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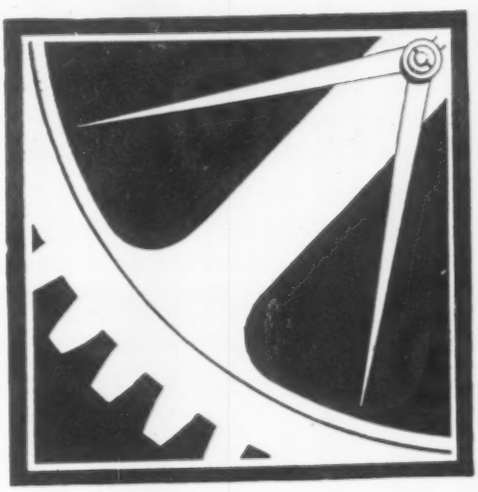
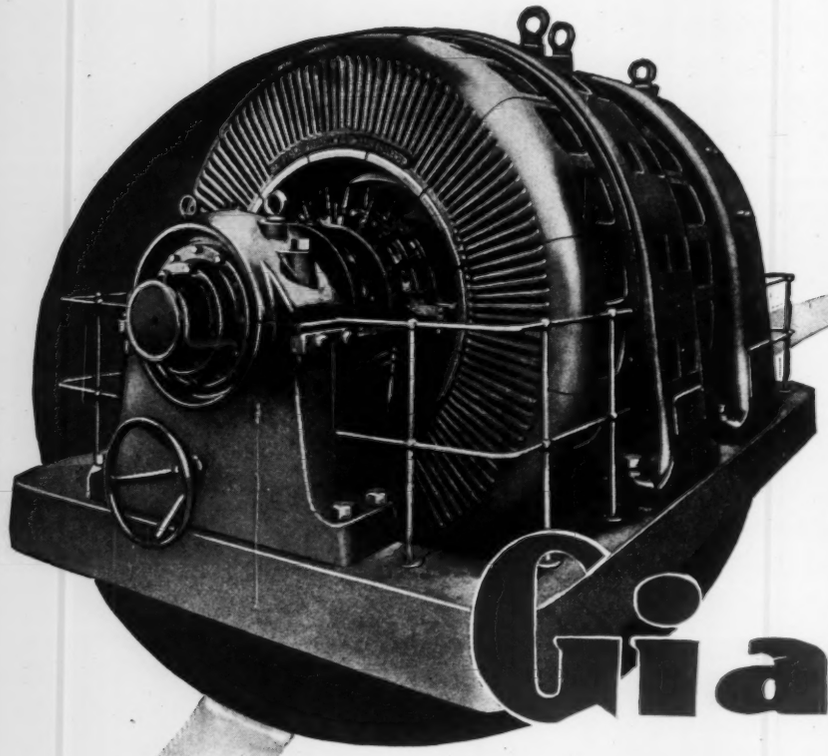


AS IT AFFECTS

ENGINEERING–PRODUCTION–SALES



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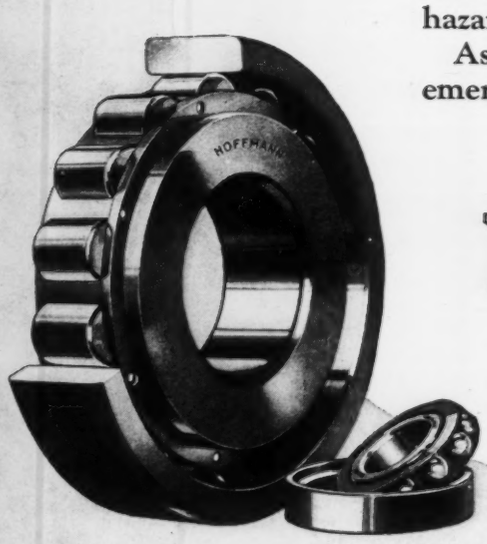

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MACHINE DESIGN

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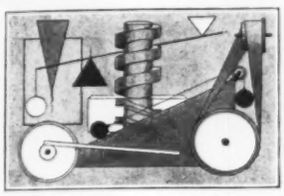
ENGINEERING–PRODUCTION–SALES

Volume 2 | April, 1930 | Number 4



Forthcoming ISSUES

AMONG outstanding articles scheduled for inclusion in the next issue is a valuable discussion on the design of springs. It will be the first of a series on this important subject, written by one of the best known authorities in the country on spring design.

Also in an early issue will be published a contribution on the application of stampings in design. This will be found particularly timely in view of the increasing use of the stamping process. Discussions covering other processes in which the design profession is vitally interested will appear from time to time.

L. E. Jermy.

Managing Editor

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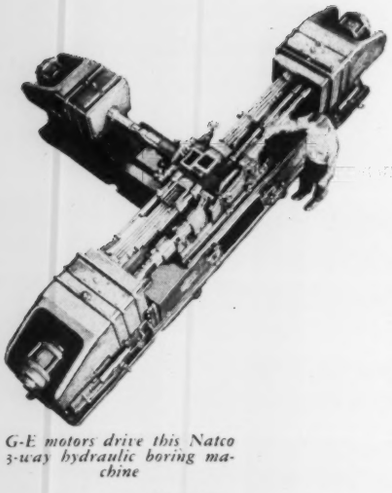
Out of the "Stunt" Class



G-E motors drive this Natco 3-way hydraulic boring machine

G-E Type FTR 20-hp. motor drive on Natco 2-way lead screw tapper. Complete protection against phase reversal and phase or power failure is provided through G-E control

TO drill on one casting face—mill another—and to bore on a third—all at the same time—these were the "circus stunts" of yesterday. Complexities of drive forbade much of that.

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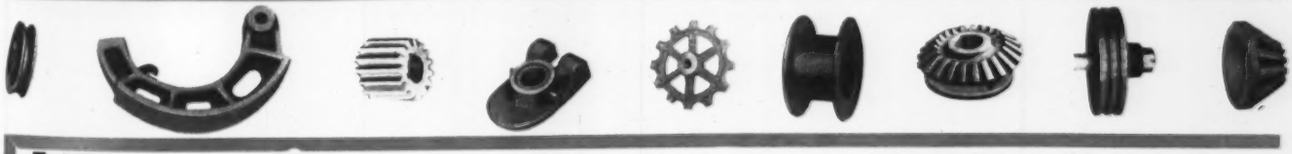

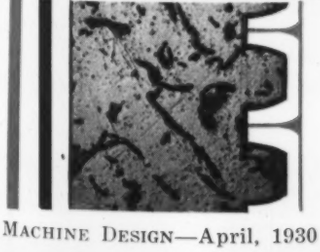

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Calendar of Meetings and Expositions

April 22-25—American Welding Society. Annual meeting at society headquarters in New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary.

April 23-26—Congress for Automobile Standardization. Third International congress to be held at Milan, Italy.

April 28-May 3—National Power Show. To be held in connection with the International Textile exposition at Mechanics building, Boston. For information write to New England Association of Commercial Engineers, 53 Devonshire street, Boston.

May 1-3—American Gear Manufacturers association. Fourteenth annual meeting to be held at Hotel Gibson, Cincinnati. Officers will be elected and members to the executive committee chosen. At the technical sessions Dr. L. R. Koller, General Electric Co., will talk on photo-electric cells; A. H. Candee, Gleason Works, Rochester, N. Y., will present a paper discussing gear nomenclature, Emil Dukes, Gear & Forings Inc., Cleveland, is scheduled to deliver a paper on load and speed conditions of worm gear drives; and E. F. DuBrul, general manager of the National Machine Tool Builders association will talk on "The Outlook for New Developments in the Machine Tool Industry." T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary

May 2—American Society of Mechanical Engineers. One day textile meeting sponsored by the textile division of the society to be held at Hotel Statler, Boston, during the Textile Machinery exposition. P. A. Merriam, executive committee of the textile division, is arranging the technical program.

May 5-10—American Mining congress. Seventh annual convention of practical coal operating officials to be held in conjunction with the national exposition of coal mining machinery and equipment at Cincinnati. The meeting and exposition will cover mechanical mining and phases of the coal mining industry.

May 7-9—American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore hotel, Atlanta, Ga. David L. Fiske, 37 West Thirty-ninth street, New York, is secretary of the society.

May 12-16—American Foundrymen's association. Annual convention at public auditorium, Cleveland. The program provides for three round table luncheon meetings, covering malleable, steel and nonferrous foundry practice. Three shop operation courses are scheduled covering steel foundry operation, gray iron foundry operation and nonferrous foundry practice. Each course will consist of a series of three or four sessions. C. E. Hoyt, 222 West Adams street, Chicago, is secretary of the association.

May 19-22—American Society of Mechanical Engineers. Fourth national aeronautic meeting at Dayton, O., and Wright field. The meeting will be held under the auspices of the aeronautical division of the society. Orville Wright and Gen. B. D. Foulois will be the honorary chairmen. The program has been selected to afford interesting technical papers on a wide variety of live topics. Among the speakers will be Dr. Elmer A. Sperry, Lieut. J. Doolittle, Major G. E. Brower, Prof. Wagner, of Danzig, Germany, Claude Dornier, of Friedrichshafen, Germany, Per Orbem, of Paris, Lieut. A. F. Hagenberger and many others of equal prominence. The papers will cover both lighter than air and airplane types. They include problems of design and construction practice, aerodynamics, engine performance and fuel problems, quantity production, metal plane development, flying boats, autogiro, etc. A part of each day will be devoted to inspection tours of the extensive laboratories and hangars at Wright field and through nearby airplane and accessory factories. Some of the sessions will be held at Wright field. Headquarters for the meeting will be maintained at the Biltmore hotel, Dayton, O.

May 25-29—Society of Automotive Engineers. Summer meetings at French Lick Springs hotel, French Lick Springs, Ind. Coker F. Clarkson, 29 West Thirty-ninth street, New York, is secretary.

June 9-12—American Society of Mechanical Engineers. Semiannual meeting to be held at the Book-Cadillac hotel, Detroit. At least 20 technical sessions besides interesting plant inspection trips and entertainment are scheduled. Jervis B. Webb, of the Detroit section, is chairman of the arrangements committee. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

June 12-14—American Society of Mechanical Engineers. Third national meeting of the Oil and Gas Power division of the society to be held at Pennsylvania State college. Julius Kuttner, who is in charge of the technical program has announced that there will be about 15 papers presented at the five sessions. On Friday evening, June 13, a banquet will be held. An exposition will be held in the armory on the campus grounds at the time of the meeting.

June 16-20—Association of Iron and Steel Electrical Engineers. Annual meeting and iron and steel exposition at Broadway auditorium, Buffalo, N. Y. John F. Kelly, 1010 Empire building, Pittsburgh, is managing director.

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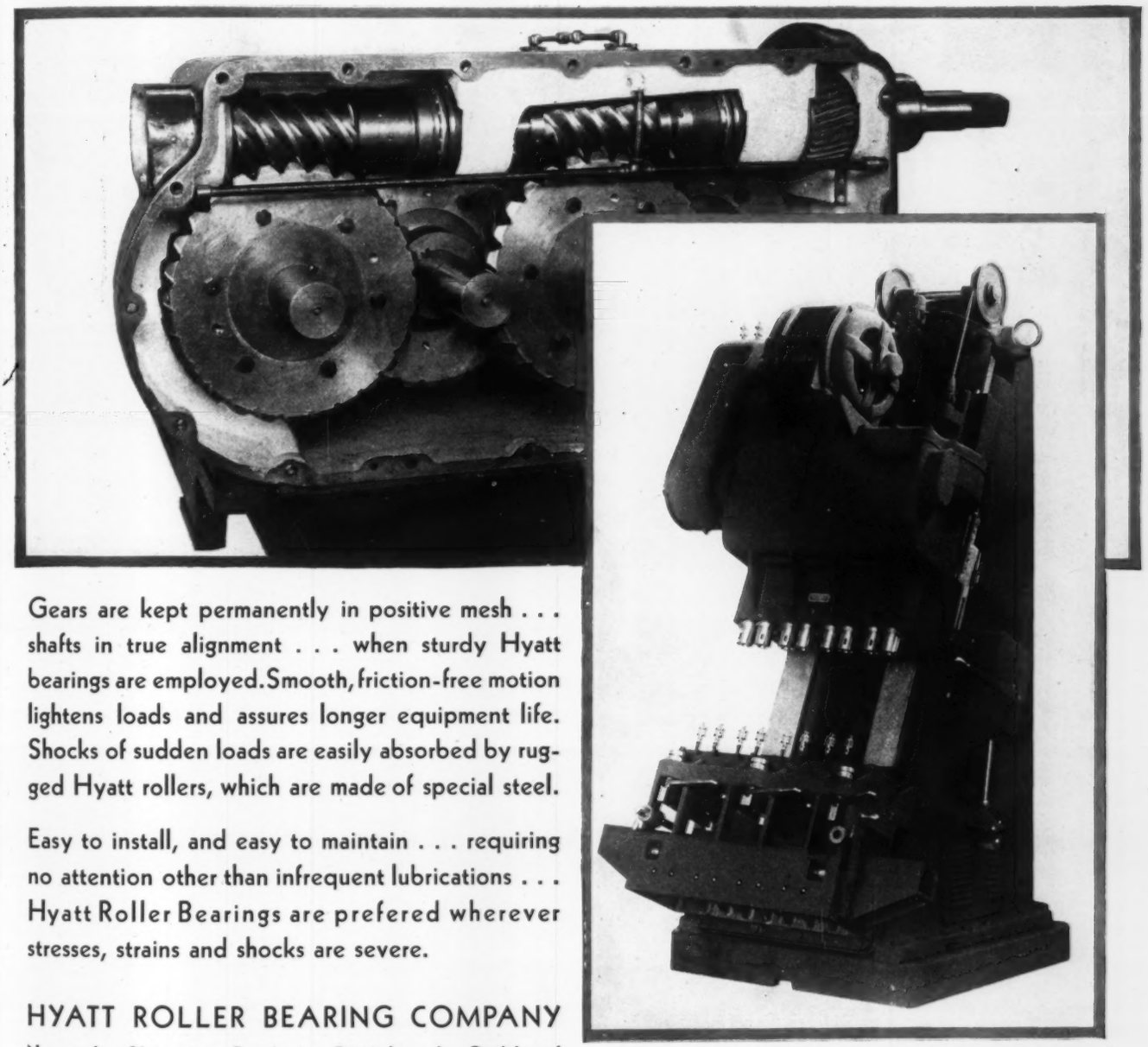

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(Above, left) Gear box of 8 spindle Foote-Burt inclined drill press showing application of Hyatt Roller Bearings to worm shafts. Three Hyatts are used on each shaft . . . a total of six Hyatts for this particular unit. (At right) Complete view of 8 spindle drill press, built and Hyatt protected by the Foote-Burt Company, Cleveland.

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MACHINE DESIGN
April 1930

Intermittent Use Controls Design of Agricultural Machines

By J. Brownlee Davidson

WIDELY recognized as one of the outstanding authorities in the field of agricultural machinery design, Professor Davidson, author of the accompanying article, not only is head of agricultural engineering, Iowa State College of Agriculture and Mechanic Arts, but is vice president in charge of engineering, General Implement Co., Racine, Wis.

AGRICULTURAL machinery is in many respects the most difficult class of machinery to design. The machines must be simple, must function to a high degree of perfection, operate under most adverse conditions, and yet must be produced at a cost which will make a limited annual use profitable. A farm machinery survey made in Iowa indicated that farm machines were used on an average of but 16 days a year and many machines were used but four or five days. It is customary to refer to agricultural machines as the result of invention, but while invention has played an important part in the establishment of the principles of their operation, the manufacture of a satisfactory machine required in addition the expenditure of much thought, experimentation, testing in the field, and production engineering as well.

A new agricultural machine usually begins with a conception of a mechanical device for performing a manual operation, or for replacing another less efficient device used for a certain purpose. Under normal circumstances, the following procedure outlined as to the various steps involved, is typical of the method followed in designing, developing, and manufacturing a new

Fig. 1—Typical scene on modern farm equipped with power machinery

machine. The development may be discontinued after any step in the procedure, if previous results do not justify a continuance.

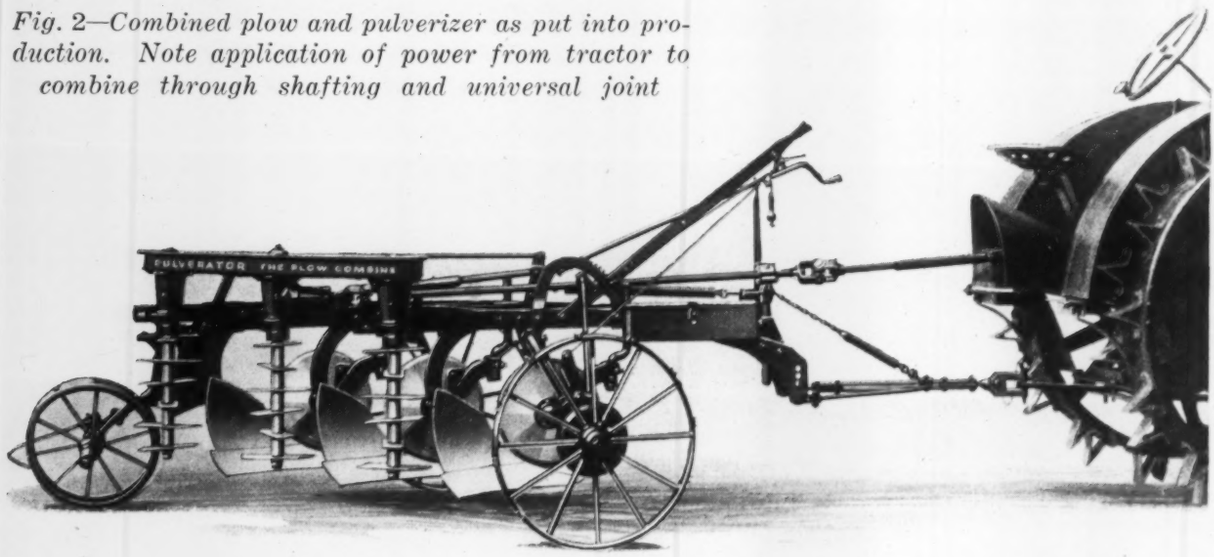
1. The conception of a machine or a part of a machine, or a device which will make it possible to perform a certain task with better economy or with less dangerous or irksome labor than by present practice.

Outlines Procedure In Design

2. A survey to determine the need and possible demand for the proposed machine, together with a complete analysis of present methods or practice, to determine the cost of labor and power used, the cost of operation and its influence on the quality of work performed or the materials handled.

3. The construction of an experimental machine with special provisions for experimental adjustments to determine relationships, location, strength of parts, general requirements, etc.

Fig. 2—Combined plow and pulverizer as put into production. Note application of power from tractor to combine through shafting and universal joint



4. Test of an experimental machine with trials at a sufficient number of settings or adjustments to determine the optimum relationship of parts, to determine whether the mechanism will function successfully, to obtain certain strength requirements not calculable, and to determine if performance is in general satisfactory. The tests of experimental machines should be made under all the various conditions the machine may be expected to encounter.

5. The design and construction of a small lot of machines, usually 3 to 25 machines, in which the results of the tests of the experimental machine are made use of and due consideration is given to the kind and proportion of materials best adapted to meet the requirement of the machine and best suited to manufacturing.

6. Tests of the semi-experimental machines, preferably in the hands of operators not responsible for its construction and unfamiliar with its peculiar characteristics. As in the former instance the tests should be made under all conditions the machines may be expected to encounter. Carefully observed records of performance are made for analysis and study.

7. A review of the design of the machine by production engineers with a view of using for the various parts the most desirable material capable of being fabricated in the most efficient and economical way. It is to be noted that materials and methods will depend upon the number of machines to be made. For instance, a pressed steel part made in dies may be practical for 5000 machines yet quite impractical for 500 machines on account of the cost of the dies.

8. Production of machines for market which involves a comprehensive plan for the manufacture of each part, including the selection of factory machines and the design and construction of patterns, jigs, dies, special machines, assembling lines, finishing or painting equipment, and adequate facilities for inspection and test.

Other Items To Be Considered

9. The preparation of setting up and operating instructions, repair catalogs and assistance in writing of advertising literature.

10. Establishment of cost of production and fixing of selling price.

The foregoing explanation would indicate that the original conception or perhaps invention as the case may be, is only a first step toward a

practicable farm machine which may be manufactured and sold in sufficient volume to permit the cost to be lowered to a practicable sum. Much expense is involved in the development of a machine through this process. The cost of an experimental machine is many times that of the final machine. Owing to the expense involved most of the farm machinery development of the present time is carried out by well organized engineering staffs of large manufacturing concerns. The organization of the engineering staff of the various manufacturers will vary much and the methods of investigating and approving work on new machines differ, but in general the procedure will be somewhat similar to the plan outlined.

Much of the development of farm machines comes about by a slight modification of existing machines and the process of development of modifications are simpler than for an entirely new machine. No small part of these modifications are suggested by the users and salesmen of these machines.

The conditions under which a farm machine must operate are particularly severe and adverse to favorable machine operation. The machine must be light for field operation which makes it difficult to maintain alignment for bearings. The conditions of service vary through wide extremes due to differences of soil, climate, and crops. The machine must work in dust and grit, which makes lubrication difficult. It is subject to shocks and severe stresses.

Essentials of Farm Machine Design

The requirements of a well designed farm machine may be summarized as follows:

Fig. 3—Experimental machine adjustable in every respect for test purposes

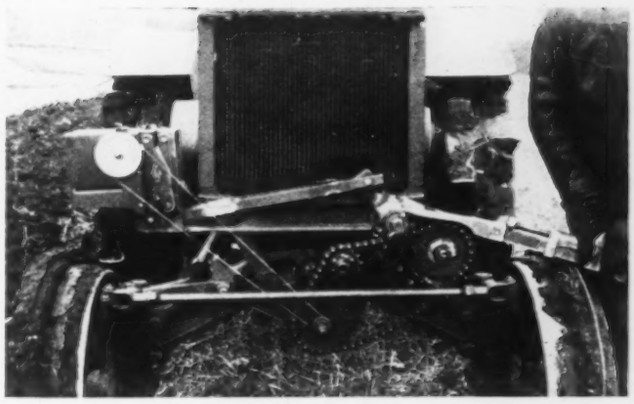


Fig. 4—Torque dynamometer for measuring power consumed through power take-off

1. The machine must perform its work successfully.
2. The cost must be sufficiently low to permit economic operation.
3. It must save labor and power.
4. It should be durable, reliable, simple, and easily maintained.
5. Lubrication should be adequate, effective and easily applied.
6. All parts must be accessible for repair and adjustment for the most part with ordinary tools.
7. All parts should be made interchangeable for replacement, permitting all repairs to be made in the field without special equipment.
8. All wearing parts should be either adjustable or replaceable at small expense.
9. Important assembly parts should be made as units for easy replacement.
10. The machine must be safe to operate.
11. It must be convenient and easy to operate.
12. It should be attractive in appearance.
13. It should be easily transported and stored.
14. It should be designed to facilitate shipment.
15. It should not be greatly affected by exposure to the weather.

The various steps in the design and production of an agricultural machine may be illustrated by the design of a new tillage machine known as the Pulverator and shown in the accompanying illustrations. In its conception, the machine represents an effort to apply the power of the mechanical motor directly to the preparation of a seed bed. The power of the

ALLUDING to developments in power farming methods as discussed briefly in the February issue of MACHINE DESIGN, *the use of tractors in the United States during the 10-year period, 1918 to 1928, increased three-fold. The vast influence of mechanization on man's ability to increase his capacity further is signified by the accomplishments of farm equipment. In order to help lower labor costs the agricultural colleges of the South are emphasizing the increased amount of work possible with cultivators over the older methods of the one-mule operator. Particularly in localities where intensive farming is practiced the improvement in design of agricultural machinery has had a notable effect. In small equipment, machines have been so much improved and simplified that one machine may be used to seed all vegetables either in rows or hills, and to weed, mulch and cultivate, simply by using different attachments. It is significant also that many men prefer to use the rotary hoe for the first and sometimes the second cultivations. Drawn with the tractor at high speed, this tool will cover from 60 to 80 acres a day. The use of better tools such as hill-drop planters, riding and tractor cultivators not only allows more time for production of crops but greatly reduces amount of man labor necessary for this purpose.*

tractor motor when applied through the draw-bar is reduced by many losses, by friction of transmission parts, and by the rolling resistance and slippage of the steering and traction wheels. Often the efficiency of power applied through the draw-bar is less than 50 per cent. The transmission of power with a single speed reduction and a flexible shaft should be much higher.

Fig. 3 shows an experimental machine constructed to establish the relationship of parts. The pulverizing heads have interchangeable blades of different lengths. The location of the pulverizer heads may be shifted and the speed of rotation may be varied by changing the driving sprockets. With a torque dynamometer to measure the power applied to the machine through the flexible shaft, a traction dynamometer to measure the power applied through the draw-bar and with careful observations of the quality of work performed with each setting it is possible, by conducting a series of tests, to determine with engineering soundness the most desirable relationships of the parts, and the best speed at which to operate. With definite data of performance available, it is then possible to proceed with the design of an experimental lot.

Fig. 5 shows an experimental machine in the semi-production stage and Fig. 2 the final design which was put into production. The usual procedure in preparing parts lists, setting up instructions, operating instructions, and advertising literature was carried out, thus completing the program to be followed in the design and manufacture of a new machine.

Fig. 5—Machine in the semiproduction stage undergoing severe tests

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Features and Trends in Design

CONSTANT changes in the design of engine pistons might lead to the belief that redesign in this field had been exhausted, at least until such time as a new material especially adapted to meet conditions in gasoline engines is discovered. That this is not the case, however, is borne out by the production of a new type of piston embodying somewhat revolutionary design ideas by the Sterling Products Corp., St. Louis.

As will be noted from Fig. 1, the head of this piston is fitted with an insert passed through milled slots in the second ring groove and machined to contact with the second ring. The insert is of invar for the purpose of minimizing expansion under heat.

At maximum temperature, the expansion of the centering ring and invar insert is less than that of the jacketed cylinder, thus making possible the fitting of this assembly to the cylinder with zero clearance, and avoiding the possibility of seizing at full load. Another striking feature is that the piston skirt is machined an oval cone with the maximum diameter crosswise the piston at the bottom with the minimum diameter front to rear. The maximum diameter is machined to 0.003-inch larger than the cylinder bore and the minimum diameter is considerably less to allow for full free expansion of the skirt.

At the upper end of the skirt the piston tapers into a round construction adjacent to the lowering ring. The skirt is made relatively thin and of uniform thickness, and flexibility is such that it is fitted to the cylinder under 0.003-inch tension at zones 1 as illustrated.

With both ends of the piston fitted with minimum clearance, piston slap is avoided. It can also be seen that the flexible skirt with large contact areas of low unit tension will transmit heat from the piston to the jacketed cylinder as fast as it is applied, thus holding piston temperature at little above the cylinder barrel temperature.

Clutches Employ Centrifugal Action

TREMENDOUS activity has taken place of late in the design of clutches. Some of these embody new applications of old and commonly used principles; others, however, incorporate ideas not generally employed in the field of transmission. On these pages numerous examples will be found which are particularly interesting from the aspect of application of the ideas employed, in other fields.

Centrifugal action was mentioned in these columns last month as a means for loading or placing material. Another use described was that of sorting heavy from light particles as in the case of a tobacco feed. This month its employment again is demonstrated, in connection with the clutch put out by A. B. Pulvis, Stockholm, Sweden, and being introduced in this country by Capt. Nils Wallenius, 114 East Fifty-second street, New York.

Fig. 1—Piston incorporates invar insert for center ring and other novel design features

As will be seen from Fig. 4 the interior of the cylindrical clutch housing is corrugated, with the winged hub free to revolve within it. Power is transmitted by a steel powder which partially

IDEAS IN CLUTCHES AND REDUCTION UNITS

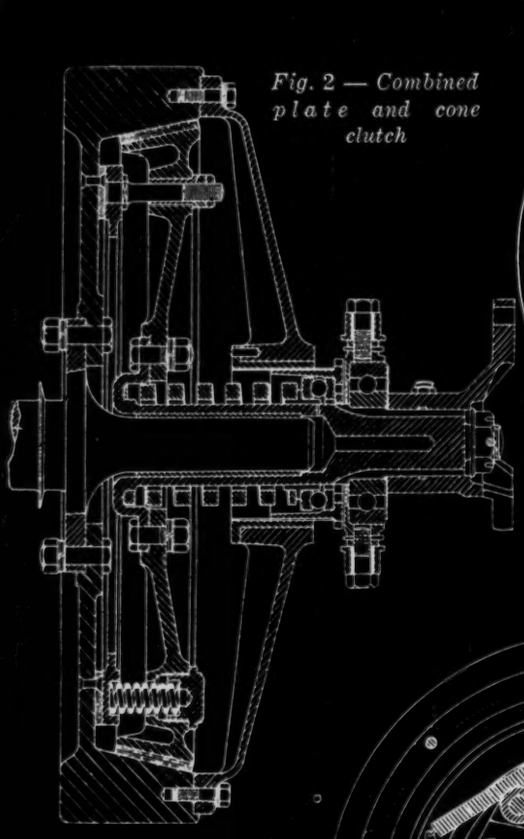


Fig. 2 — Combined plate and cone clutch

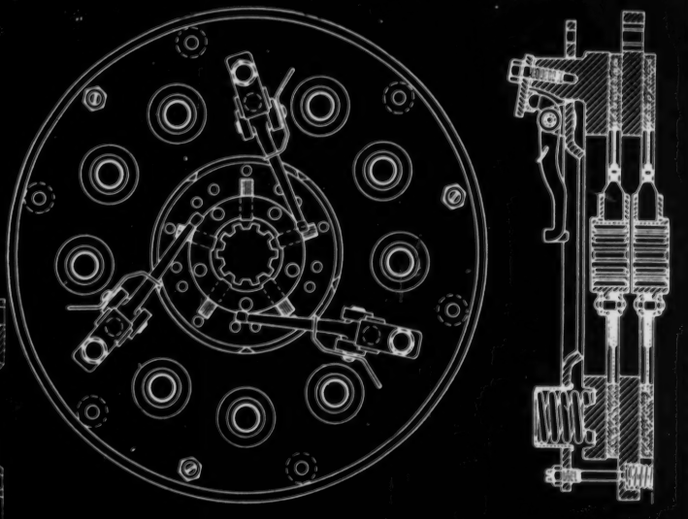


Fig. 5 — (Above) — The Tower clutch, shown above in side view and cross-section, incorporates variable leverage control

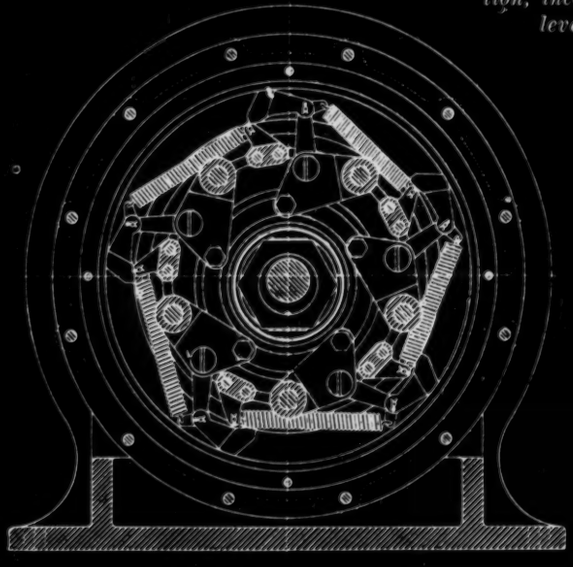


Fig. 3—(Center)—Revocentric reducer with which it is possible to vary speed infinitely from zero to one-thirteenth of the input speed

Fig. 6—(Below)—Recently patented clutch in which sloping faces in driving and driven members vary the effective pressure on plates. At extreme right is circular section on line 2-2

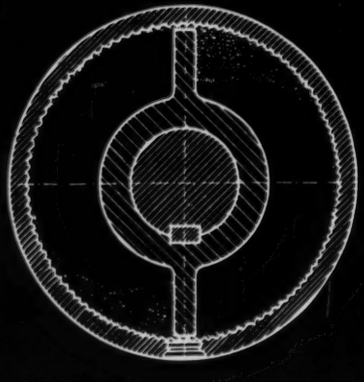
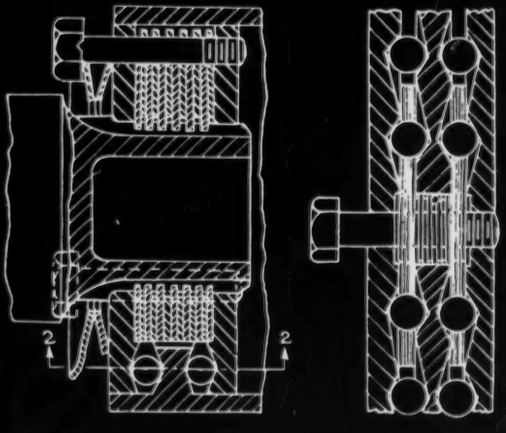


Fig. 4 — (Left) — Diagram showing powder forming in dense masses in front of driving lugs of Pulvis clutch



fills the space between the two members. Drifts of powder form ahead of the wings, as indicated in the diagram, and centrifugal force causes the density of the powder to be increased to a point where the friction on the corrugated surface of the housing is sufficient to hold the two members stationary in relation to one another. The clutch operates entirely dry, save for a small amount of grease applied to the side plates.

This unit serves the purpose of a gradually accelerating slipping clutch. It is claimed that if the load on the driven machine increases above the point for which the coupling is designed the machine slows down, while the motor continues at normal speed. As the load decreases, the machine again accelerates to motor speed.

Uses Fluid for Expansion

A SIMILAR type of clutch, illustrated in Fig. 7, has been announced by the Washburn shops of the Worcester Polytechnic institute, Worcester, Mass. The principle is exactly the same as in the foregoing clutch insofar as centrifugal operation is concerned; fluid, however, is employed instead of powder. In this case the fluid is sealed within a rotating flexible container. Uniform distribution of the material takes place during the time interval required for the motor to approach full speed without load and the gradual building up of the centrifugal force or pressure imparts a smooth pickup to the machine.

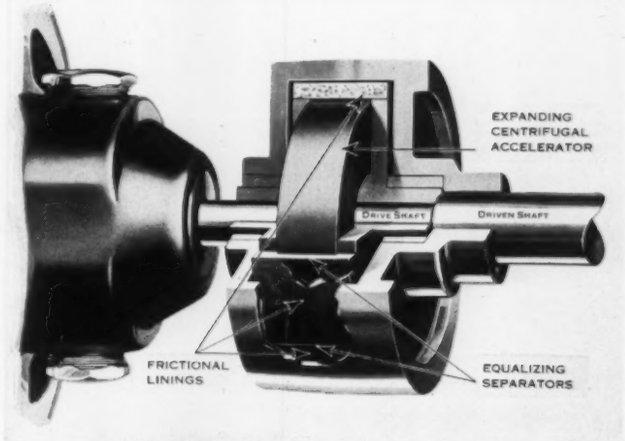


Fig. 7—Fluid under centrifugal action causes expansion of accelerator ring

Differing distinctly from the foregoing, yet embodying ideas capable of many applications other than in driving clutches, is the invention of Roland Chilton. This recently was patented and assigned to Eclipse Machine Co., Elmira Heights, New York. The object of the clutch, shown in Fig. 6, is to provide means for varying the slipping load in the forward and reverse directions.

Driving pressure is effected in the usual way by means of dished springs acting or friction disks connected to the driving and driven members respectively. The feature of the clutch, however, lies in the fact that where excessive driving load occurs, pressure between the two members is relieved by the action of the sloping inner faces between which balls are interposed in circular rows. If the slope of one set of faces is made extremely slight, a relatively great separating reaction will be produced from a small driving load.

Reversal of the direction of rotation with one member remaining the driver will vary the effective driving load. Over-run of the driving member by the driven member without change in the direction of rotation also will cause the clutch to slip while maintaining a slight frictional drag against the over-run.

Applies Well Known Principles

AN AUTOMOBILE clutch embodying old ideas but illustrating an excellent adaption of combination of methods is shown in Fig. 2. It is, as noted by *Automotive Industries*, a D & B type, manufactured by the makers of Karrier trucks and buses, Huddersfield, England. From the drawing it will be seen that the plate and cone type of clutch both are incorporated in the unit. When the pedal is released the plate section engages first and will transmit the torque required for normal acceleration. Full release of the pedal permits the cone section to engage, when the maximum torque of the engine can be transmitted.

The clutch is particularly smooth in action and one reason for this is that the plate section when engaged acts as a guide for the cone. Approximately 3/32-inch withdrawal movement is allowed for the cone, axially, before the plates commence to separate; during that movement the spring pressure on the plate is reduced progressively owing to the springs having the cone as an abutment. A clutch brake is fitted to facilitate changing into a higher gear.

Another automobile clutch for which the claim is made that no grab occurs on engagement is the Tower clutch placed on the market by the Russell Mfg. Co., Middletown, Conn. The construction is clearly indicated in Fig. 5, and the levers through which smooth engaging action is effected may be noted. At the outer end of each lever is a hardened ball point which is designed to

wear in proportion to the friction facing thus obviating by compensation the necessity for adjustment.

Reducer Employs Variable Eccentric

IN FIG. 3 is shown the Revocentric reducer described on page 29 of the March issue. Since that description was published numerous inquiries have been received regarding the unit; for this reason MACHINE DESIGN is including a drawing in the present issue.

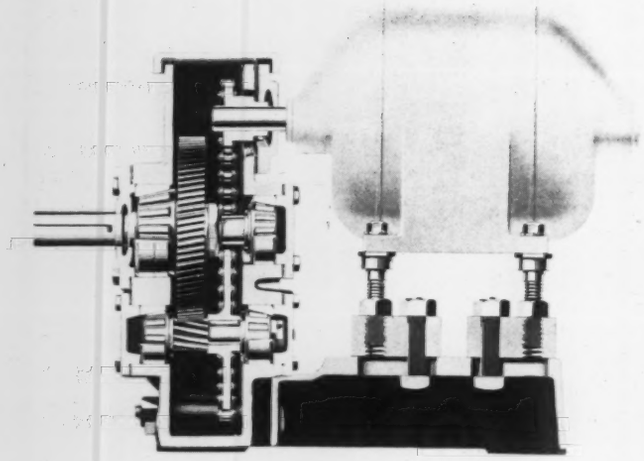


Fig. 8—Redesigned clutch uses spiral gearing

It will be remembered that the reducer is infinitely variable from zero, with output shaft stationary, to one-thirteenth of a revolution of the output shaft for each revolution of the driver. The variation is obtained by means of an adjustable eccentric acting upon a series of toggle joints.

In reduction units of the gear type, employment of herringbone and spiral gear continues to increase. Cullman Wheel Co., 1346 Altgeld street, Chicago, has adopted the spiral gear in their reducer patented recently and shown in Fig. 8. Formerly spur gearing was used. Another change in this unit is the employment of antifriction bearings, and several changes have been made in the lubrication system. At the point where the motor shaft enters the reducer, the hub of the sprocket has been extended into the oil chamber, displacing the ring used previously. Oil is sprayed inside the unit by the roller chain for the first reduction.

Loader Embodies Unique Action

IN THE mining machinery field a track cleaner has been introduced by Joy Mfg. Co., Franklin, Pa., with which it is possible for a small crew to accomplish as much work as 20 men employed with shovels. This is one more example of the mechanization of mines and goes to prove the increasing necessity for design of automatic and semi-automatic machinery to replace manual labor.

Coal-gathering arms constitute one of the main features of the machine. These arms may be seen in the foreground in Fig. 9. They are power driven from the operating mechanism, each arm being pivoted on a circular revolving disk. As will be noted, the sweeping or gather-action is controlled by the extended portion of the arm; this slides in a block attached to the chute at a short distance from the edge of the revolving disk. The movement is unusual and should serve to stimulate thought on problems involving similar action.

Another interesting feature of the machine is embodied in the conveyor chain, this having universal links which enable it to bend sideways when it is necessary to turn the rear end of the conveyor through an angle for loading purposes. The joints of the chain are not universal but have both horizontal and vertical pins to permit bending in two directions.

Employs Eccentric Principle

READERS of MACHINE DESIGN will remember the article on valve mechanism of the new Cadillac V-16 engine. In this article, which appeared on page 28 of the February issue, it was shown that an eccentric is employed to main-

Fig. 9—Loader has unique gathering arms

tain the correct valve adjustment when increase of temperature occurs in the engine.

Another adaptation of the eccentric principle which, while not exactly similar, bears some relation to the one described, may be found in the automatic overload trip placed on the market recently by Lowerator Mfg. Co., Pearl and York streets, Brooklyn, N. Y. This overload protector is illustrated in Fig. 10, as applied to a belt drive. The tight or driving side of the belt passes over the pulley 1, which is mounted eccentrically. If the tension on the belt is increased beyond normal, the eccentric mounting of the pulley rotates against the resistance of spring 3, which may be adjusted to suit the limit of power to be transmitted.

If the eccentric movement continues beyond a certain point, cam 4 will release trip shoe 5 and open the motor control switch 8. Pulley I is mounted on a stud shaft eccentrically attached to spindle II. The spring arm 2 also is attached to spindle II, and nut 10 is used for obtaining the required spring tension. This spindle assembly, with its trip cam 4, is mounted in ball bearings to insure sensitiveness. The tripping mechanism consists, in addition to cam 4 and shoe 5, of a switch trigger 6 and reset lever 7, to the outer end of which is attached a spring. The electric switch operated by trigger 6 is enclosed in casing 8.

An excessive load tends, of course, to straighten the driving belt, which in turn, tends to shift the eccentric against the action of spring 3, the size and adjustment of which depend upon the load required. The operating characteristics of a machine can be compensated for by the amount of travel of cam 4 relative to trip shoe 5, before disengagement. In resetting the tripping mechanism, lever 7 is raised against the tension of its spring until trip shoe 5 clears cam 4, when the later, with the eccentric shaft and pulley, are forced around by spring 3 so that shoe 5 rests upon the cam. When trigger 6 is raised to its normal position, the switch in casing 8 may be reset.

New Use for Chromium Plating

CHROMIUM plating has filled a definite need in industry and new applications always command a great deal of interest. Recently it was found that an important savings in time and costs could be effected by its use on gages, tools and machine parts. This noteworthy discovery was made by the Ford Motor Co., Detroit, as the result of the successful application of hard chrome plating on these items.

It was known that the use of hard chrome plate would add greatly to the length of life of these tools. The problem was to find the right kind of steel to use, as well as the right method of manufacture, so that the hard chrome plate would stay

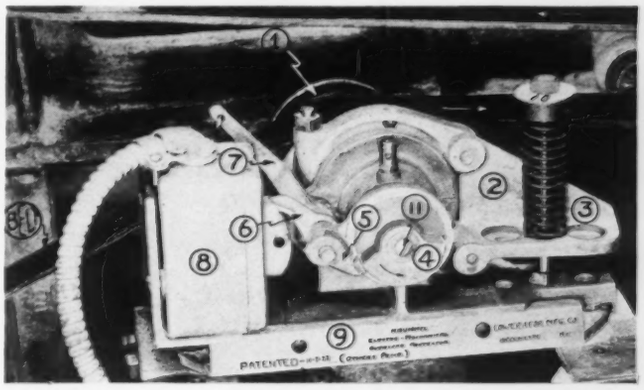


Fig. 10.—Automatic trip operated by belt pull

on, instead of peeling or chipping off. In some cases, the plating was so soft that it could be filed.

Experiments were conducted to find the kind of wheels to use in grinding the steel, and the proper method of heat treatment. By use of the plate gages now are giving 218 hours in certain grinding operations, where formerly four was the limit. Costs have been reduced more than one-half. Gaging applications that cost 8¼ to 9½ mills declined to 3½ and 4½ mills.

The snap gage used in checking the diameter of the crankshaft pin bearings has a wearing surface limit on each side of 0.0001-inch. After this was used up, the gage went back to the tool room. The short life was caused by the fact that the surface of each gage had an annealed skin, varying in depth from a few millionths to a possible thickness of 0.0002-inch. It may have been annealed by the heat of the grinding wheel at the time the gage was ground. When the surface was tested for hardness, the machine normally used penetrated the soft portion and for that reason failed to check the wearing surface.

Another example was the plug gage used on the small end of the connecting rod. Before it was plated, it could be used only about 1300 times before it had to be retired because of wear; after plating, this increased to 18,034 holes. The cost decreased from 3¼ mills per application to ½ mill. The wear allowed on this gage before scrapping is only 0.00005-inch.

On tool fixtures such as multiple heads, grinding spindles, drill press spindles and similar steel parts, some cold-heading dies and sliding surfaces where friction develops, the parts will show a saving of from six to 20 times after plating. The life of gages, tools, centers and machine parts on the job is being increased many fold.

Strength of Modern Aluminum Alloys Is Selection Factor

By F. V. Hartman

COMBINATION of lightness together with mechanical strength makes the use of aluminum desirable for moving parts of machines, and for the construction of certain types of structures where the greater part of the stresses are caused by the dead weight of the structure. Resistance to atmospheric corrosion as well as to the action of many common chemical reagents is a valuable property in numerous instances. The metal has found wide use in the electrical industry because of its excellent conductivity, while the fact that all commercial aluminum alloys are non-magnetic makes them well suited for many other applications in the electrical field. Most aluminum alloys are good conductors of heat, an important characteristic for such uses as automobile engine pistons.

BECAUSE all phases of design demand of those engaged in it a comprehensive knowledge of materials and processes, MACHINE DESIGN *is continuing its policy of publishing authoritative articles on these subjects. The writer of the accompanying discussion is research engineer with the Aluminum Co. of America at their New Kensington, Pa. research laboratories. In a subsequent article, Mr. Hartman will deal with aluminum alloys in wrought form.*

Aluminum in its commercially pure form has substantially lower strength than its alloys. It also is difficult to cast but its use is indicated for certain chemical and electrical equipment. The alloys have a wide range of properties and uses, and for this reason such terms as "aluminum" or "aluminum castings" are very indefinite. They should not be used by designers in specifying material.

Casting By Various Processes

Aluminum castings are made by three processes; these are sand casting, permanent mould casting, and die casting. The sand casting process

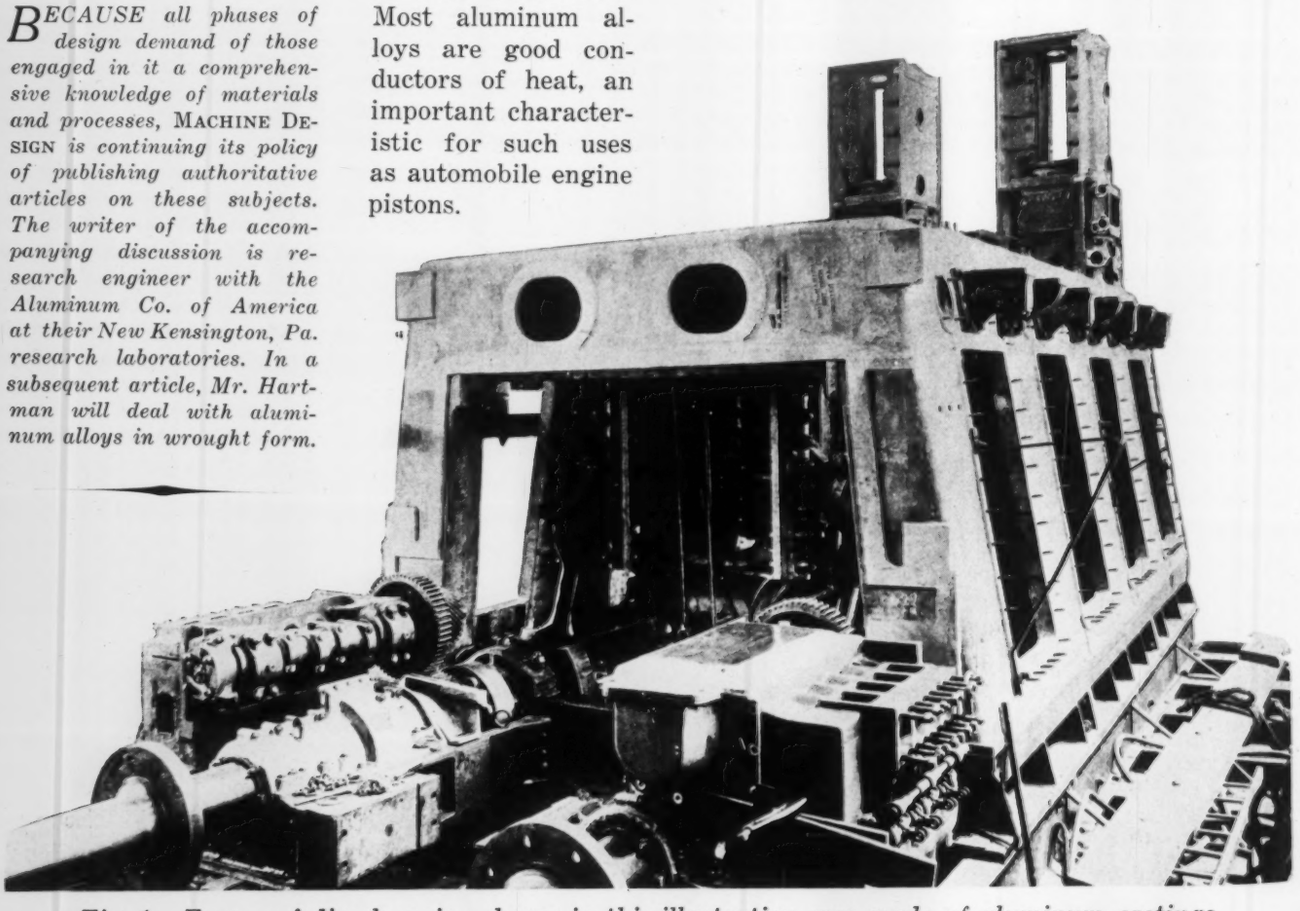


Fig. 1—Frame of diesel engine shown in this illustration was made of aluminum castings

is used most commonly as it is the only process feasible for castings that are made in small quantities or that are large in size. Sand castings cannot be expected to meet close tolerances and hence suitable allowances must be made for finishing. Tolerances for sand castings depend largely upon the type of pattern equipment used, the way in which the mold is made and the size and shape of the casting. Because so many variables are present to affect the size and weight of the finished castings, it is difficult to give, in general, tolerances for sand castings. The sand casting process is commonly used for such castings as motor crank cases, oil pans and gear cases, and for machine parts such as frames, brackets, and large fittings.

Manufacture of aluminum castings is not confined to small sizes of castings. Castings weighing 1200 pounds have been successfully made and heat treated from No. 195 alloy while castings weighing 3800 pounds have been cast of alloy No. 112. A better idea of the size of these castings is obtained when it is realized that they correspond in size to iron or steel castings weighing approximately three times as much.

Permanent mold castings, made in metal molds, are the most sound of the three types of castings. Because of the chilling effect of the mold, they are stronger than sand castings. Tolerances of a sixty-fourth of an inch can be met, and this together with good machinability accounts for an appreciable reduction in finishing costs. Probably the largest use that is made of the permanent mold process is for manufacture of pistons for internal combustion engines. Other articles made by this process are automobile brake shoes, pipe fittings, small gear blanks, ironing machine shoes and numerous small machine parts.

TABLE I

Composition of Aluminum Alloys

Aluminum Alloy No.	Approximate Compositions, Per cent Al	Cu	Si	Zn	Mn	Fe	Mg
12	92	8	.....	.....	.....	.....	.....
112	90	7	.....	1.5	.....	1.25	.....
195	95	4	1	.....	.....	.....	.....
109	88	12	.....	.....	.....	.....	.....
106	98	.....	.....	.....	2	.....	.....
43	95	.....	5	.....	.....	.....	.....
45	90	.....	10	.....	.....	.....	.....
47(mod)	87	.....	13	.....	.....	.....	.....
122	88.50	10	.....	.....	.....	1.25	0.25

The die casting process also is economical for large quantity production. Such castings have a smooth surface and finishing usually involves only the removal of fins before polishing. Die castings can be made to close tolerances—within only a few thousandths of an inch for small pieces. This process is most commonly used for relatively small parts such as carburetors, typewriter frames, meter cases, novelties, small machine parts, brackets, and fittings.

Some Design Considerations

Since aluminum castings often are used for the sole purpose of obtaining light weight construction, mechanical properties, characteristics, and uses of the various alloys must be understood to realize fully the advantage of weight saving. Obviously the metal in a casting should be distributed properly and the section kept as small as possible in low stressed areas. In this connection it should be appreciated that, when properly handled in the foundry, most aluminum alloys can be cast in relatively thin sections as compared with some of the ferrous casting alloys. From this it follows that, as a rule, aluminum castings can be better proportioned in regard to distribution of the metal so that low stressed section need not be unnecessarily bulky.

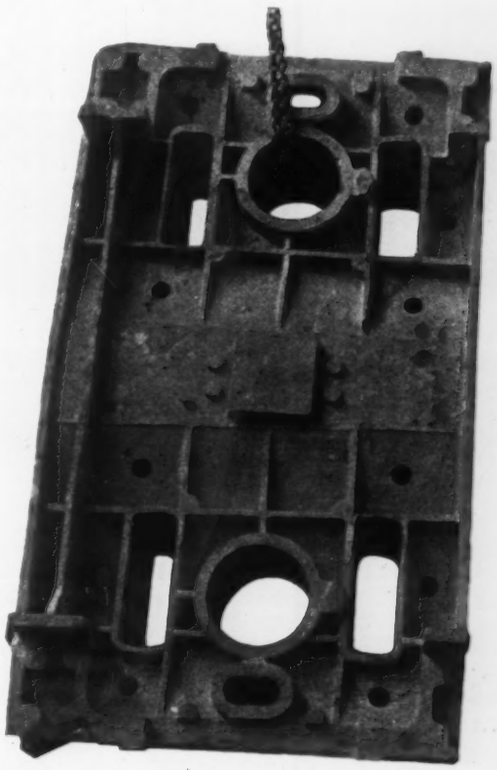


Fig. 2—Cored aluminum casting weighing 3800 pounds

Selection of design stresses is one of the designer's first considerations. It is recognized that no definite rule or rules can be made for the selection of the proper design stresses or factors of safety to meet all conditions. The designer is confronted with variable or unknown factors or conditions which make it impracticable if not impossible for him to completely analyze the stresses to which the parts of his proposed ma-

chine may be subjected. Hence, design stresses must be selected to suit as nearly as possible the conditions under consideration and the proper selection is largely a matter of experience.

Ordinarily for tensile and compressive stresses under static loading a design stress of one-fourth the ultimate strength is employed; this corresponds to a factor of safety of four based upon the ultimate strength of the material. Some aluminum alloys in certain tempers or conditions have a relatively high yield point, exceeding one-half the ultimate strength. For such alloys a design stress equal to about one-half the yield point often is considered safe. This practice applies in general to the design of machine elements and structural members in tension, short members in compression, beams, and containers or vessels subject to internal pressure.

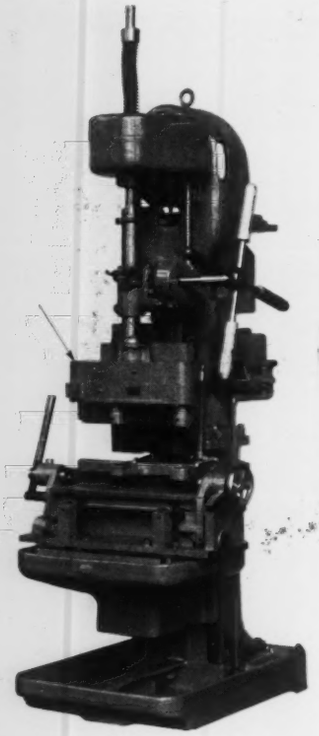


Fig. 3—Aluminum is finding many applications in the machine tool industry as exemplified by the illustration shown at left and also in Fig. 4. The picture adjacent is a multiple spindle drill which embodies a drill head constructed of aluminum

When a member is subjected to a repeated or alternating stress, the design stress should be taken as 80 per cent of the fatigue limit of the material. When subjected to impact or suddenly applied load, the design stress should be based on a larger factor of safety, the selection of such a factor should correspond to similar design practice when using steel.

Properties Change With Temperature

Temperature considerations are important in the use of aluminum alloys, and must not be overlooked by the designer. The physical properties of aluminum and its alloys change with increasing temperature; therefore physical properties of the metal at its highest operating temperature govern the strength of a design. As a rule, the strength, hardness and stiffness of aluminum decrease and the ductility increases with an increase in temperature within the practical temperature range in which aluminum alloys ordinarily are employed. Hence, lower design stresses must be used when the designer is confronted with elevated temperature operating conditions. Factors applying to the design stresses of certain aluminum casting alloys at elevated temperatures are given in Table III. To correct for elevated temperature, the design stress that would be selected for normal room temperature conditions should be multiplied by the proper factor taken from this table.

The modulus of elasticity for practically all commercial aluminum alloys in both the cast and the wrought condition is approximately 10,000,000 pounds per square inch. Since steel has a modulus of elasticity of 29,000,000 pounds per square inch, this means that under the same unit stress, aluminum alloys will deform about three times as much as steel, provided the proportional limit is not exceeded. In many structures the deflections or deformations due to stress are negligible. However, in cases where they may be important enough to be taken into account in the design, it may be necessary to work at lower unit stresses and to increase the depths of beams in order to avoid deflections in aluminum structures in excess of those in similar steel structures. This generally can be done and yet obtain an appre-

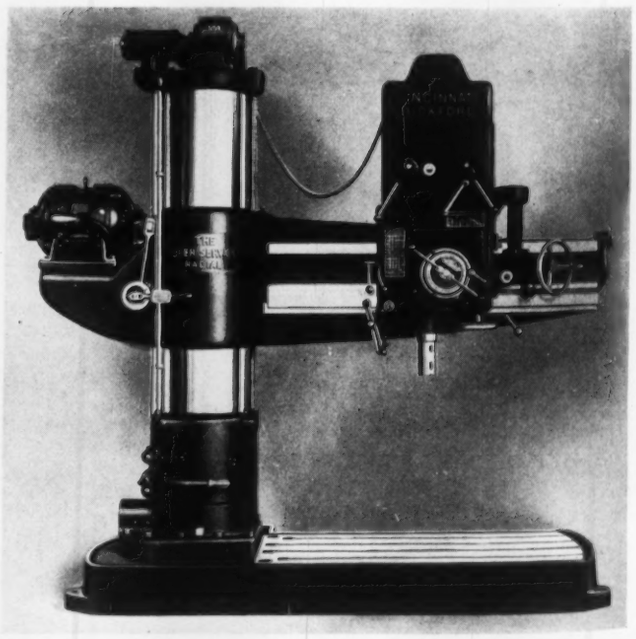


Fig. 4—Aluminum castings in driving head of radial drill result in less deflection of arm

ciable saving in weight. The modulus of elasticity of cast iron is only 12,000,000 pounds per square inch and for cast or rolled brass the value is approximately 15,000,000 pounds per square inch; hence the difference between the deflection of an aluminum structure and one made from these metals is seldom of appreciable significance.

Low specific gravity of aluminum castings makes them especially well suited for reciprocating parts of machinery. This is illustrated by the wide use of aluminum pistons in internal combustion motors. It should be appreciated, however, that the heat conductivity of aluminum also is an important property contributing to the success of aluminum pistons.

Lightness Permits Higher Speeds

Aluminum castings have been used successfully for parts of automatic machinery which move intermittently and must start and stop quickly. This refers particularly to large reciprocating tables and to rotating tables operated by such means as cams, the geneva stop motion, or by specially controlled motor drive. The use of aluminum castings for such parts makes possible a light weight construction which permits higher speeds, resulting in increased production. For intermittent motion parts where there is no object in increased speeds, the use of light weight aluminum construction may result in considerable economy by reducing the size of the driving mechanism and power unit which in turn will reduce the power cost.

These castings also lend themselves readily to cast rotating parts of machines for applications in which the principal stresses result from centrifugal forces. For example, a rotor of cast aluminum identical in size to one of cast iron and operated at the same speed will be stressed only about one-third as much from centrifugal forces, since centrifugal forces is directly proportional to the weight of the rotating mass. From this it follows that the aluminum rotor can be made of small sections or operated at a greater speed. Such increased speed can be used to advantage for increasing production in some types of machinery.

The designer often is required to use screws

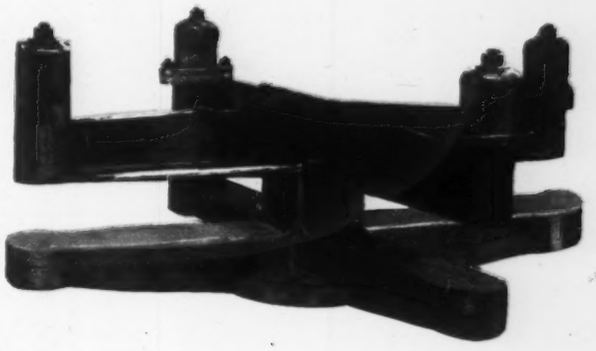


Fig. 5—Double cross-arm table of aluminum with arms 42 inches overall illustrates use for high speed intermittently rotating parts

for joining castings together or for fastening brackets or attachments to a casting. In such cases, through bolts are usually preferred in castings of iron or other metals and the same is true for aluminum castings. There are many instances, however, where studs and sometimes tap bolts must be used. In these cases, where screw threads are tapped into aluminum castings, the coarse or U. S. Standard screw thread is recommended. The depth of a tapped hole should be equal to from one and one-half to two times the diameter of the screw for all commonly used aluminum casting alloys. This depth is not dependent on the shear strength of the casting alloy

TABLE II

Average Mechanical Properties of Aluminum Sand Casting Alloys

Alloy No.	Average Ultimate Tensile Strength Lb. per Sq. In.	Approximate Yield Point Lb. per Sq. In.	Average Elongation in 2 inches per cent	Approximate Brinell Hardness	Approximate Fatigue Limit Lb. per Sq. In.
12	22000	11000	1.5	65	....
112	23000	18000	1.5	85	8500
195–4*	31000	13500	8.0	65	6000
195–16	36000	22000	4.0	85	6000
195–10	40000	27000	2.0	90	7000
109	24000	18000	1.0	79	10000
106	20000	9000	10.0	35	5500
43	19000	9000	4.0	40	6500
45	22000	10000	4.0	50	....
47 (modified)	26000	11000	8.0	52	6000
122	30000	25000	0.5	95	9500

*Numbers affixed to Alloy 195 indicate different heat treatments.

since tests made on the strength of tapped threads, using cold rolled steel studs, indicate that a depth of thread equal to only one diameter of the screw is sufficient to cause failure by tension of the stud even for most of the low strength

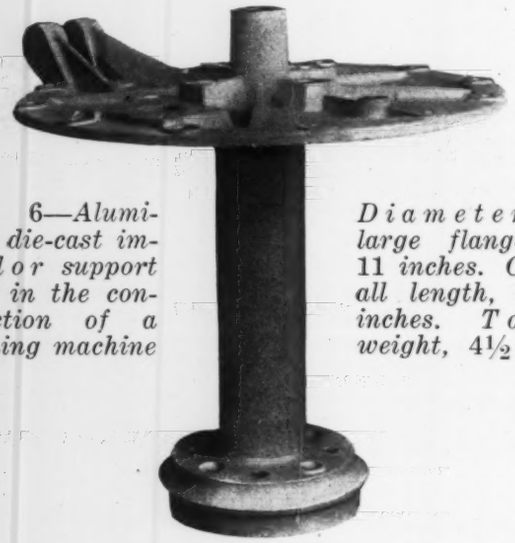


Fig. 6—Aluminum die-cast impellor support used in the construction of a washing machine

Diameter of large flange is 11 inches. Overall length, 11½ inches. Total weight, 4½ lbs.

aluminum casting alloys. Therefore the depth of thread for a stud is dependent on the amount necessary to give sufficient friction to anchor the stud securely against removal when a nut is unscrewed from its free end. The depth of a tapped thread into which a tap bolt is screwed is determined by the frequency with which the screw must be removed since frequent removals will in time cause the thread to wear out. It is apparent that some judgment must be used in selection of the proper depth of a tapped thread in aluminum castings and this is in agreement with design practice with other casting metals.

Electrolytic Action May Occur

When steel studs or bolts are used with aluminum alloys, some electrolytic action may take place under conditions favoring corrosion. In such cases galvanized steel generally is used. Strong aluminum alloy screws and bolts are obtainable and may be used in place of steel. When aluminum screws and bolts are used, a suitable anti-seize compound should be employed to prevent seizing of the threads. Aluminum screws and bolts will be discussed in more detail in a subsequent article.

Properties of some of the more common sand cast alloys are given in Table II. For general casting purposes, No. 12 and No. 112 alloys are used. Because these alloys are handled easily in the foundry, and have very good machining characteristics, they are used quite extensively in the automotive industry for such parts as crank cases, oil pans, gear covers, transmission housings, etc. For parts which must be leak proof under pressure, as for example, manifolds, alloy 109 formerly was used. At the present time, the aluminum-silicon alloys more generally are employed.

Aluminum-silicon alloys Nos. 43, 45 and 47, are fluid at temperatures almost down to the freezing point, and have a low solidification shrinkage. This combination of properties makes it possible to cast intricate shapes having both heavy and thin sections without excessive use of chills and risers. The castings are dense and leak proof. Silicon has a lower specific gravity than aluminum, and its alloys with aluminum are lighter than commercially pure aluminum. Because aluminum-silicon alloys resist salt water corrosion better than aluminum-copper alloys, they are used extensively in marine construction.

The properties given for alloy 47 are obtained by treating, or modifying, molten alloy with metallic sodium or Alpax Grain Refiner. This modification treatment retards the particle growth of silicon and gives a fine grained alloy. Castings made from unmodified alloy show coarse crystalline fractures and inferior mechanical properties unless chill cast.

Alloy 106 is used almost exclusively for small parts, such as pipe fittings, in which shrinkage can be taken care of easily. Such fittings are

(*Concluded on Page* 51)

TABLE III

Factors Applying to Design Stresses at Elevated Temperatures

Alloy No.	Temperature in Degrees Fahrenheit 100	200	300	400	500
112	1.0	0.95	0.95	0.90	0.70
195–4	1.0	1.00	1.00	0.85	0.60
109	1.0	0.95	0.85	0.75	0.55
106	1.0	0.95	0.90	0.75	0.65
43	1.0	0.80	0.70	0.55	0.40
47 (modified)	1.0	0.90	0.75	0.60	0.40
122	1.0	0.90	0.85	0.75	0.60

Four-Speed Transmission Units Indicative of New Gear Trends

By Austin M. Wolf

Automotive Consulting Engineer, Newark, N. J.

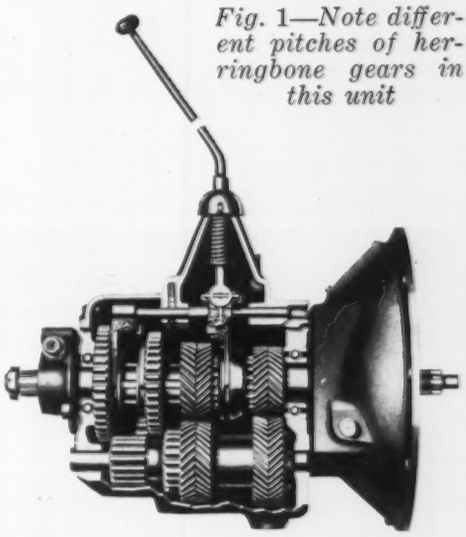


Fig. 1—Note different pitches of herringbone gears in this unit

WITHIN the last two years the four-speed transmission has made considerable headway in its adoption for passenger car use. By this it should not be surmised that the three-speed type has never been questioned, as Winton and Lozier built many years ago a unit having a geared-up fourth speed. Their aim in holding down engine speeds at high car speeds early anticipated the present trend but success was not possible due to lack of up-to-date manufacturing facilities, processes and materials.

The particular drawback to early four-speed units was noisy operation. Trucks have used these transmissions all along due to their comparatively greater loading per horsepower, requiring therefore a greater range of ratios between engine and driving axle. Due to the different requirements and type of service, experience gained in this field was not directly applicable to passenger car design.

As one of the most significant reasons for the increasing adoption of four-speed transmissions, it should be mentioned that high engine speeds inherent with the three-speed gear are undesirable due to the excessive inertia forces developed, these resulting in abnormal bearing loads. Vibration and noise also are factors. Hence the desire to decrease the number of engine revolutions per wheel revolution at high speeds, in a quiet manner, and still to obtain the maneuver and accelerative ability we have been accustomed to with three-speed cars having a large rear axle ratio, such as 4½ or 5-1.

The historical fourth speed overdrive mentioned has been investigated again recently with a different form of transmission gearing. This includes the use of the large axle reduction. High propeller shaft speeds ensue as a result and the tendency toward whipping, which is a just cause for anxiety, is greater. The question of whether to have direct drive in third or fourth speed is beset with arguments on both sides. The concensus of opinion lies with the direct-

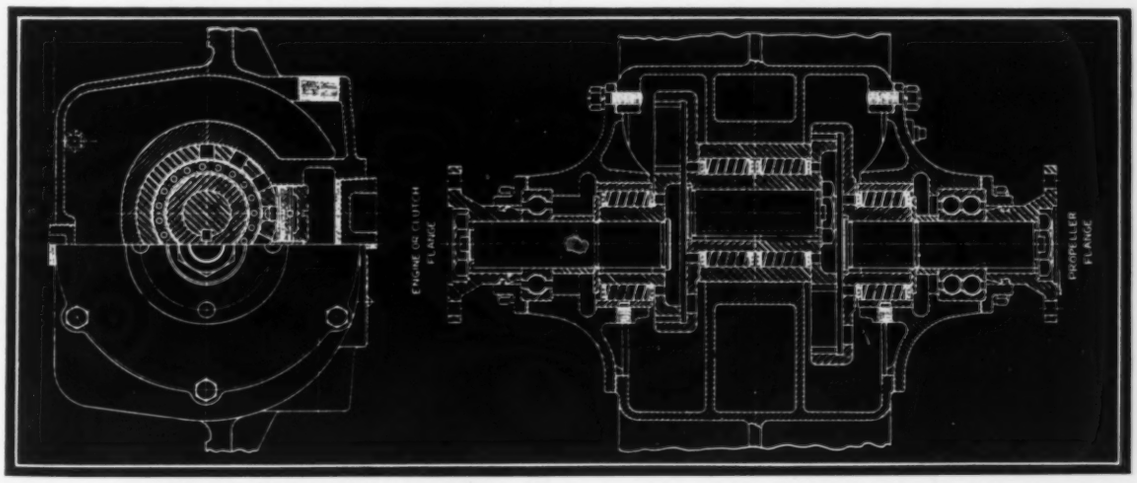


Fig. 2—Reduction gear for marine engines embodies auto transmission principles

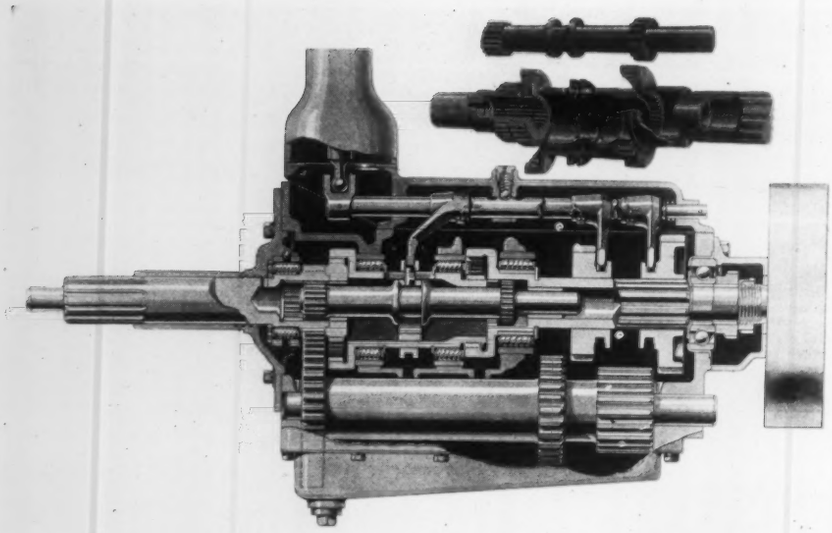


Fig. 3—In the Graham unit an internal gear meshes continually with third speed gear

in-fourth construction, which eliminates high propeller shaft speeds. In this case a lower axle reduction is used, such as 3.9-1. In third speed the overall reduction (transmission and axle) ranges around 5.3 or 5.5-1, simulating the old three-speed overall ratio. Reduction in engine revolutions in fourth speed is considerable and fuel economy can be brought about in this way better than by any other means. In order to insure easy selection of either of the higher speeds, special means are provided to make the shift as easy as possible.

It is interesting to note that another system using internal gearing has had a considerable impetus during this development and leads in the number of designs. The greater number of teeth in contact and the smaller pitch used result in smoother and more silent running, besides having greater torque capacity. There should be numerous possibilities for its application other than automotive, such as in machine tools where smoothness of drive is certain to result in better finish of the fabricated part as well as long life for the machine. Herringbone gears are being used in the quest for quietness and again widespread applications are possible. Spur gear constructions are being refined as a result of the competition of other forms.

We will now consider some of the various transmissions that are being used today. A discussion of the details should be suggestive of their possible application to numerous phases of machine design.

Graham and Durant pioneered the internal gear movement and Fig. 3 shows a partial sectional view of the former, with the internal gear unit depicted above. First, second and reverse speeds, together with the countershaft drive, are obtained in the customary manner. Instead of the rear end of the clutch shaft being machined out to receive the usual spigot bearing, it is provided with internal splines. Piloted on a flange adjacent the clutch shaft pinion lies the third speed gear and it has like internal splines. The gear cannot shift endwise, due to the proximity of the sleeve unit. This member is provided at its forward end with an internal gear which meshes continually with the third speed gear.

Gears Are Constantly in Mesh

This is possible due to mounting of the sleeve unit "off-center," in relation to the clutch and final drive shafts. The rear end of the sleeve unit has an external gear constantly in mesh with the internal gear at the forward end of the final drive shaft. The sliding shaft, shown in the topmost view, has a centrally located groove and external splines at each end, the forward one being considerably wider than the rear. This wide portion is always engaged with the internal splines of the clutch shaft. In the sectional view, the sliding shaft is in the

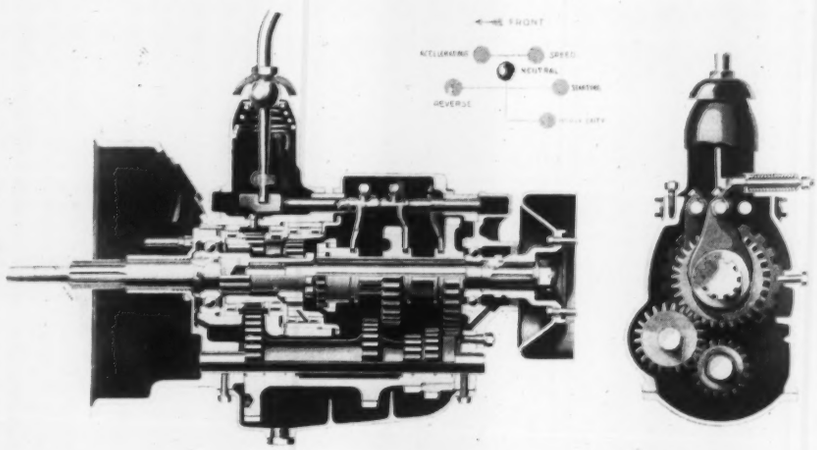


Fig. 4—Offsetting sleeve above clutch shaft center provides compact design in the Chrysler transmission

neutral position. Shifting it to the right, the third-speed gear is picked up by the wide spline of the sliding shaft, thereby uniting it with the clutch shaft. A reduction now is effected by driving the sleeve, which in turn actuates the final drive shaft. Direct drive is obtained when the sliding shaft is shifted to the left, so that the narrow splines engage co-acting splines in the final drive shaft.

To shift the sliding shaft, in view of its eccentric relation with the sleeve, an inner and outer ring are supported by the latter and are pinned together, three notches in the sleeve accommodating the pins. The shifting fork engages the outer ring, and the inner ring tangentially engages the groove of the sliding shaft. The use of large diameter antifriction bearings is to be noted in this and other designs, bearing directly on the rotating members without the use of an inner race in order to hold outside diameters to a minimum; also the bottom pressed steel cover plate which simplifies assembly and provides greater accessibility.

An extremely compact entity is disclosed in the Chrysler construction, shown in Fig. 4. The countershaft is driven from the sleeve unit and therefore after only the first internal gear reduction. Due to the eccentric offsetting of the sleeve above the clutch shaft center, the center distance between the latter and the countershaft can be kept small. Attention is directed to the drilling of oil holes in all the rotating members to insure distribution of the lubricant. The enclosure of the gearing does not allow the free access for oil as in the ordinary spur gear type of transmission. One of the first internal gear transmissions provided a small gear type pump to establish oil circulation but this has not been found necessary in later developments.

Second Speed Used in Starting

Under ordinary conditions first speed is not used and is only held in reserve for emergency, second being used for starting. Whereas some makers use a latch on the shifting lever, which must be raised in order to engage first speed, the latest feature is the provision of an extra heavy spring in the way of the shifting lever to prevent accidental picking up of first speed. A deliberate pressure thereby is required on the lever to engage it. This construction is shown in the right view of Fig. 4. The shift positions are indicated in the upper portion of the figure.

Still another combination of elements is indicated in Fig. 5 which shows the design made by the Detroit Gear and Machine Co. The internal gear reduction is obtained by the most compact layout yet developed. The sleeve unit is in this case of minimum length. Basically the methods of obtaining third and fourth speeds comprise the clutching operations of the design shown in Fig. 3. The sliding gear on the final-drive shaft engages either reverse or first speed. An external spur gear surrounds the internal gear at the front end of the final drive shaft. A sliding gear on the countershaft engages the aforementioned gear for second. The sliding shaft in this design has an integral spline to pickup the third speed gear and a keyed-on spline member for direct drive. The oil slinger to the right of the speedometer helical drive-gear prevents leakage

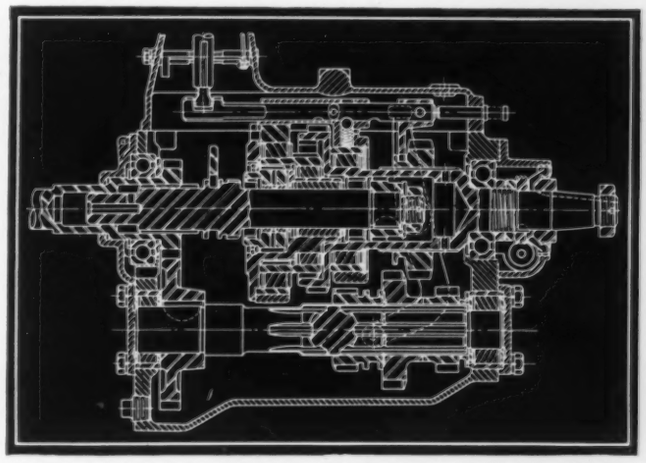


Fig. 5—Another compact design incorporating sleeve unit of minimum length and other features

at the rear. At the forward end spiral grooves accomplish this purpose; grooves on sealing rings will be noted in the other designs also. Whereas plain bearings have been used in the previous designs, the Detroit layout incorporates roller bearings. Side thrust is taken care of by the end caps. The right cap is of interest in shortening the length of the case by partially surrounding the outer race of the bearing.

The clutching member of all internal gear arrangements has a very small mass, which furthermore is of small diameter. Inertia forces developed are low. Hence shifting requires little effort and in most cases ease of engagement is more pronounced by shortening every second out of three teeth or splines of one of the engaging members, giving a combined tooth and dog effect.

Proof that the application of internal gear reductions is not restricted to automobile use will be seen in Fig. 2, showing a 2-1 reduction gear unit made by the Morse Chain Co. for marine work. The eccentrically mounted sleeve unit of automobile designs forms the basis of this construction. A straight line drive results and the

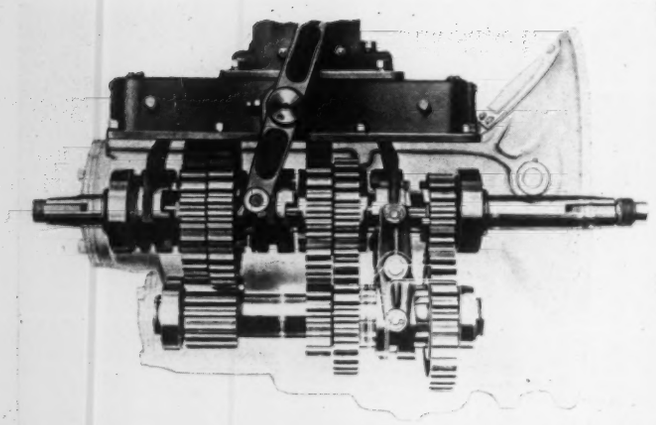


Fig. 6—Transmission used for heavy duty which adheres to use of dog clutches

higher permissible engine speed allows the use of a lighter weight engine developing greater power than the directly-coupled, slow-speed marine engine which heretofore has been the vogue. Because the gear unit usually is installed in a position where ventilating conditions are poor and to prevent any accumulation of heat, the center bridge of the casting incorporates a water jacket which can be attached to the engine cooling system.

Viewed in Pessimistic Light

When the sliding gear transmission was first used in automobiles, many engineers looked on it as a mechanical monstrosity that could not survive. They contended that "clashing" gears into mesh violated all sound engineering principles. However, while the method survived, we can appreciate the obstacles that beset pioneers who did not have the advantages of modern materials and heat treatments. Gears in constant mesh were used in the early days and were coupled to the shaft by friction clutches (which method soon died out) or by means of dog clutches. The Cotta transmission, shown in Fig. 6, still adheres to this principle and is enjoying success in heavy duty work. The gears are loose on the final drive shaft and are picked up by the stepped-tooth dog clutches shown. In direct drive the forward gear is declutched from the countershaft, therefore no gears revolve except the front meshing pair. The lever in the foreground accomplishes this move.

The internal-external gear clutch was a refinement of the dog clutch and has been used for many years to obtain direct drive in the conventional type of transmission. It also has been used in individual clutch transmissions. This precedent has made possible the clutching members shown in Figs. 3 to 5, and in the herringbone gear developments about to be described.

Fig. 1 shows the present Pierce-Arrow unit in which herringbone gears are used for the constant-mesh and third speed gears. A clutch member of the internal-external gear type on the final drive shaft picks up either the front shaft or the loose third speed gear to give either direct or third speed. Reverse, first and second, are obtained by sliding gears. The herringbone gears are formed in two halves, of different pitch, in order to break up any possible vibration synchronizations that might arise were like pitch to be used.

Four-Speed Unit Is Exception

A similar gear development in the Reo three-speed transmission was described in the November, 1929, issue of MACHINE DESIGN, page 46. The full benefit of a quiet indirect ratio, next to high, cannot be obtained except in the case of a four-speed transmission. Due to the relatively small reduction desired to make traffic "cruising" possible, there would be too great a difference between first and second in a three-speed job.

With new developments in design and methods of cutting, the herringbone gear has felt a rejuvenation and is in the infancy of a wide adaptation in numerous fields. The smoother running and silence as compared with the spur gear, gives it advantages which cater to modern methods with their scrupulously exacting demands. It will be interesting to watch the future developments of the herringbone and internal gear constructions as they both are competing for popular favor and with the same objects in view. Costs of fabrication involving materials, heat treatments and labor, together with relative efficiency and durability no doubt will decide the issue.

Standard Involute Is Quieter

The stub tooth which formerly was used exclusively in transmission work has been replaced by the standard involute form because of the quieter operation of the latter. It is interesting to note that at least one transmission for bus and truck use still retains the stub tooth for the first and reverse gears. Torque capacity is more important than silence in these speeds. Because of the small pitch diameter of these gears, the strength of the stub tooth is worthy of adoption.

There are many other fields besides the automobile where numerous speed ratios are needed in the power line and it is hoped that the description of many of the details used in the constructions here considered will act as a suggestion or inspiration to designers in general.

Many Opportunities Are Presented to Popularize Machines

By L. E. Jermy
Managing Editor, Machine Design

DOES your operator like the new machine?" This is one of the questions asked constantly when machines embodying new design features are put in service. The significance of the question can be understood from several aspects, not least of which is the matter of whether the product has been designed with consideration of the human factor well in mind.

Obviously there is a distinct retarding effect in cases where the machine embodies new features. In the first place, most operators view with a certain amount of alarm any operation or adjustment of the machine differing from that on earlier models. This feeling is more or less psychological and is extenuated by the routine type of work on which many operators are employed. In the second place the operator, having worked for months or possibly years on his old machine, has developed a liking for it; the machine, broadly speaking, has become part of the man. Therefore to switch him over to a new machine often is distasteful and not conducive for considerable time to the best performance of both man and machine.

Operator's Point of View Important

This has been appreciated in some cases by designers of production machinery, particularly where the action is not wholly automatic. It has been realized that to obtain the best results it is essential in a new machine to consider the operator's point of view and to incorporate features in the design which will have a strong appeal to the mind. The result in these cases has been to stimulate the operator's interest immediately to the extent that he will put forward every effort to obtain the best performance possible from the

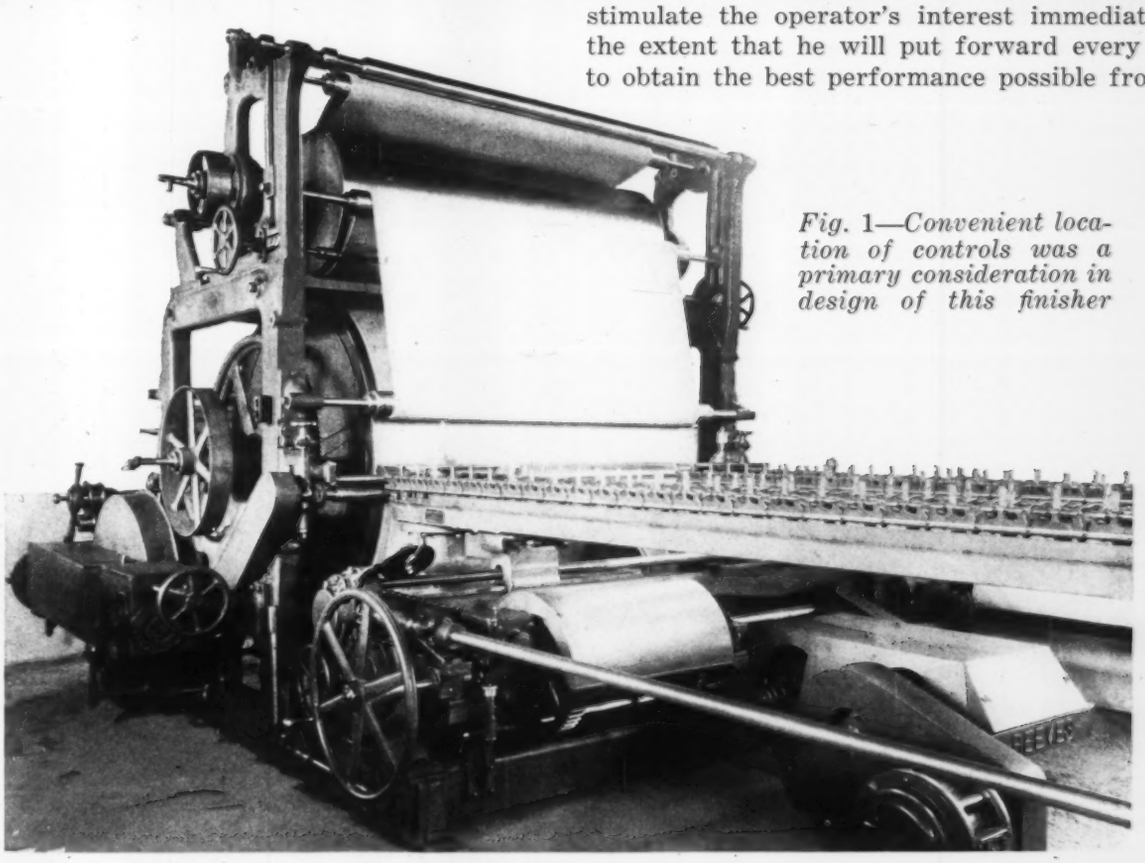


Fig. 1—Convenient location of controls was a primary consideration in design of this finisher

machine. In other words the machine will be given a far better chance to prove itself than would a machine embodying excellent production features but designed purely from this angle without consideration of the human element.

Every sales manager knows that although he is not taking repeat orders from operators, the latter are valuable allies—or bitter critics, as the

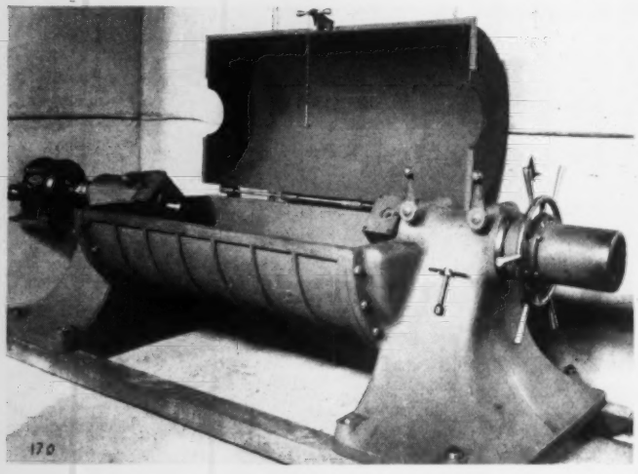


Fig. 2.—Note handwheel at right. A coarse thread is provided to facilitate quick release

case may be. And as in these days of competitive selling it is far better to have friends than foes, it behooves all sales staffs to co-operate with design departments and advise immediately any reasonable and cumulative adverse criticism with which they may come in contact.

Machinery Builders' Comments

Several excellent examples of the manner in which builders of machinery have studied the human factor in design of their machines have been brought to the notice of the editors of MACHINE DESIGN since publication of the first article on this subject in the February issue. One of these comes from a manufacturer of textile machinery, Morrison Machine Co., Paterson, N. J. In the design of its Triune finishing machine, shown in Fig. 1, which in reality consists of three machines, quetch, tenter and palmer grouped into one for continuous operation, particular attention has been paid to centralizing all controls. The operator, while standing in the most strategic position for operating the machine, has within a few inches of his hands the control wheel for maintaining synchrony of tenter and palmer, the speed wheel securing the variation of speed of the whole mechanism, the stopping and starting device controlling the whole machine, and a lever controlling the width of the cloth. The latter is ingenious; it is completely automatic, no slugging of hand wheels being necessary to change from narrow to wide goods or vice versa, but a mere pressure on a lever causing the machine to open or close automatically. This lever may be engaged even though the machine is operating at full speed, without any jar or vibration. As the lever engages, the whole tenter length moves in or out without noise. A dial about 6 inches in diameter immediately under the eye of the operator indicates automatically the exact width of the cloth.

Machine Is Provided With Locks

Every part on the machine susceptible to adjustment is furnished with locks so that the adjustment having been made to a nicety, it may be locked in that position to prevent deviation due to vibration. The hand wheel provided for manual operation of the palmer in emergencies is enclosed in a small housing having a door on the front, which is self-locking and protects not only the hand wheel but also contact with it by the operator when it is in motion. Square bars are protected by a patented lock.

It will be seen that not only has the grouping of controls been given consideration but the machine has been provided with protective guards. This is a design feature too often overlooked in the creation of machines, as is evidenced by the number and diversity of guards it is essential for maintenance departments to provide for new machines of various kinds.

On another machine built by the same company, lubrication has received major consideration. This machine, a horizontal roll extractor as shown in Fig. 2, needs oiling only once every three months. The tailstock adjusting screw is entirely enclosed and dips constantly in a trough of oil.

Another interesting feature of the machine, from the aspect of operation, is the fact that in this tailstock adjustment is effected by externally threading the main barrel and providing it with a pilot wheel actuating nut. A large diameter, coarse lead screw is employed, facilitating equal ease of motion as with a small diameter screw with fine thread, with the additional advantage of rapid traverse. Only one turn of the nut is required to release the shell as against 10 or 12 formerly.

Adjustments Are Easily Made

Fig. 3 illustrates one of the machines built by the Cleveland Folding Machine Co., Cleveland. In the operation of an earlier model it was necessary for the operator to remove several parts in changing over the machine for a different size of paper. These parts varied in weight from a few

up to about 70 pounds and considerable expenditure of effort was required to remove them. Several wrenches were necessary each time a change was made. In the re-design of the machine the necessity for removal of parts in making a change-over has been eliminated entirely, adjustments to the machine without the use of wrenches being all that is required.

Another feature in the re-design is embodied in the delivery. In the earlier machine, discharge of the folded material took place practically on the floor level. The discharge on the new machine has been raised to about 20 inches from the floor, thus obviating the necessity for the operator to stoop when collecting the finished product. This discharge table is shown in the foreground in the illustration.

The question of noise and vibration arises in connection with the method employed by the Akron Standard Mold Co., Akron, O., for driving its machines. C. B. Hudson, chief engineer, writes:

"In the quest for more efficient equipment in progressive industrial organizations today, we find they are demanding that the human factor must be considered, and new equipment designed to be quiet and easily operated.

"I am especially interested in the article published in the March issue of MACHINE DESIGN on 'Reducing Noise Necessary in Studying the Human Factor.' During the latter part of last year our attention was called to the fact that machinery for the rubber industry should be designed to operate with the least amount of noise and vibration as possible. We met this problem on our tire building machines by using rubber V-belts on all of our motor drives instead of gearing. We are pleased to state that we found this a decided advantage and reduced the noise to a negligible factor. This type of drive will be more appreciated if placed beside one using the gear drive, due to the fact that as the gears wear, the noise will increase while the rubber V-belt always will be noiseless and insulates the motor from the tire machine."

Noise Is Handicap in Flying

Significant also in respect to the matter of noise, and touching an entirely different field, is the statement of Kenneth M. Lane, chief of the engineering section, aeronautics branch of the department of commerce, Washington, D. C. This authority claims that noise is the worst thing about flying. He points out that the present plane has five sources of annoying noise. They come from the engine exhaust, propeller, slip stream effect on the fuselage and whistling of wires. He predicts that one way of reducing noise will be to lower propeller tip speeds rather than increasing them, thus eliminating noise from that source.

In the automotive industry—one in which we all are interested from the angle of our being machine operators—attention is being paid to the subject of vibration. In an article by Earl H. Smith in the *S. A. E. Journal* for February, it is pointed out that disagreeable vibrations still remain in an automobile even after all moving parts of the chassis have been perfectly balanced. The engine being the chief cause, a method of mounting to reduce transmission of vibration from it to the frame was the major problem presenting itself when the development of mountings began. A truncated pyramid shape of block gave the best results and reduced the frame vibration to one-sixth of its original value, with engine vibration remaining the same. This type of mounting has given no trouble after considerable service.

Nothing can bring to mind more clearly the serious nature of this problem of consideration of the human factor in design than actual contact with it. In numerous instances in production machinery operation, the operator is faced with vibration—not with an hour or so of "putting up with it"—but with the necessity of having to continue in his job day after day. To give him a machine or a battery of machines which is quiet, smooth-running and easy to operate—in other words, machines which are popular with him—will be the means of reaping a benefit for all concerned.

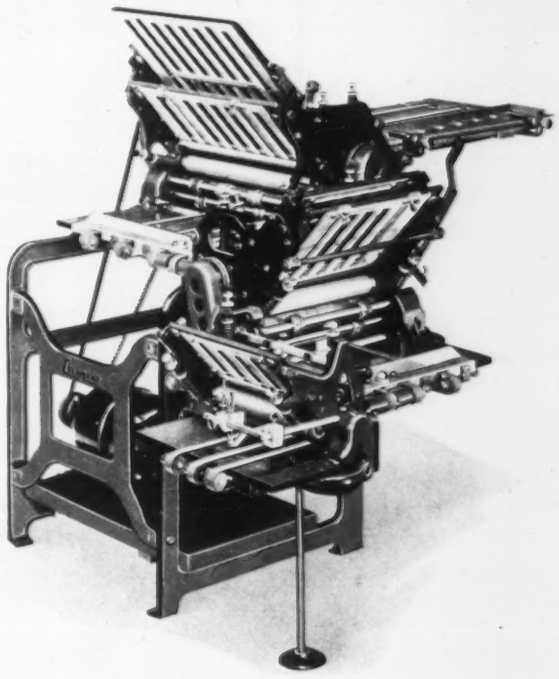


Fig. 3—Discharge table in foreground has been raised from floor to position shown

Timely Re-statement of Fundamental Mechanical Principles

By Prof. John V. Martenis, M. E.

Chief, Machine Design Division,
University of Minnesota

Gear Design—Strength of Teeth—Part 1

DESIGN of a gear naturally will be based upon certain assumptions relative to gear action and conditions under which the gear will be expected to operate, also upon the materials of which the gear is constructed. In transmitting a known torque through meshing gears, it will be necessary to determine the pressure between the acting teeth. It was shown in the article on "General Principles of Toothed Gearing" in the February issue of MACHINE DESIGN, that the path of contact in involute gearing is determined by the pressure angle and the addenda of the meshing gears; also that the limit of pure gear action is fixed by the points of tangency of the pressure line with the base circles of the gears. With a given pitch, the path of contact may be sufficient to require simultaneous action of two or more pairs of teeth. The minimum limit requires that the arc of action must at least be equal to the circular pitch. Referring to Fig. 1, it will be noted that gear action begins at point *a* and continues to *b*, and that the path of contact extends from *a* to *b*. The arc of action is the arc of the pitch circle subtending the angle of action formed by the radii drawn from points *a* and *b* to the centers of the respective gears.

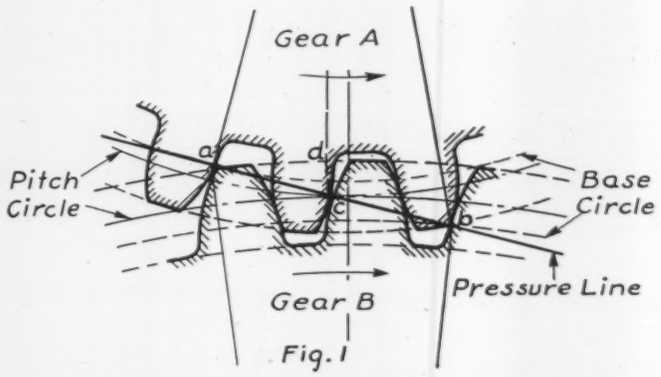


Fig. 1

For continuous gear action the arc of action must be equal to or more than the circular pitch. If the arc of action is just equal to the circular pitch, then the gear must be designed so that one tooth will carry the load, and this condition usually is assumed in the design of a gear. If the gear teeth are accurately formed, the gears rigidly supported and the shafts accurately aligned, the load imposed by one tooth on the other will be distributed uniformly over the whole face of the tooth. Otherwise the load may be concentrated on the corner of the tooth. In the case of cast gears, possible inaccuracies of the tooth outline may cause this action.

General Formula Not Practicable

Form of a tooth outline will be determined by the pressure angle and the magnitude of the base circle, therefore it is not possible to derive a general formula that will apply directly to each individual case. A further assumption usually is made in the derivation of a formula for strength of a gear tooth, namely that the tooth pressure is exerted normal to the addendum radius, whereas pressure line lies oblique to radius.

The stress to be used will be determined by the quality of the materials used, the speed at which the gears are operated and the character of the variation in the stress action.

Two fundamental formulas will be derived: case 1, in which the load is applied at the corner of the tooth; case 2, in which the load is applied over the tooth breadth.

Case 1. The tooth will be considered as a rectangular cantilever beam with the load concentrated at the corner of the tooth, as shown in Fig. 2, where the load W acts at the point e.

Bending moment due to the load is $W \times e\,d$, where $e\,d$ is the perpendicular distance from the point of application of the load to the plane $a\,f\,m\,n$ in which failure may be expected.

The resistance offered to the bending moment

consists of the working strength of the material of which the gear is made and the section modulus I/c of the rectangle $a\ f\ m\ n$. Therefore the equation is,

$$W \times e\,d = S \frac{t^2}{6} \times a\,f$$

Since $e\,d = h \times \sin\theta$ and $a\,f = h/\cos\theta$ the expression will be

$$W \times h \sin\theta = S \frac{t^2}{6} \times \frac{h}{\cos\theta} \text{ or } S = \frac{6\,W \sin\theta \cos\theta}{t^2}$$

Since $\sin\theta \cos\theta = \frac{1}{2} \times \sin 2\theta$, then

$$S = \frac{3\,W}{t^2} \sin 2\theta$$

When $\theta = 45$ degrees, then $\sin 2\theta = 1$, a maximum, hence $S = 3\,W \div t^2$.

In cast gears, a backlash is allowed to provide for inequalities of the tooth surface and for variations in casting practice. Therefore, let $t = 0.48\ p'$, in which, p' is the circular pitch.

Substituting this value of t, in the previous expression, and solving for p', then $p' = \sqrt{13\,W/S}$. This formula will not apply in cases where the width of face b is less than h. Practically, the

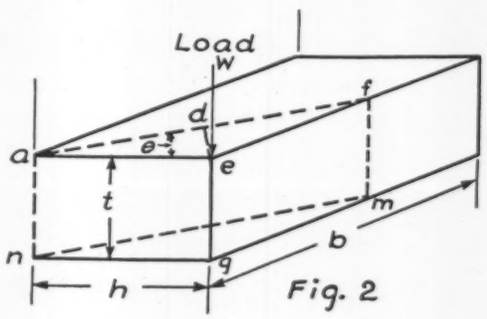


Fig. 2

width of face should be $2\ p'$ as a minimum value.

In the foregoing, no account has been taken of the reduction in tooth thickness due to wear, but on the other hand the whole load was assumed to be concentrated upon one corner. This condition will change as wear occurs, and as the tooth section is reduced the load becomes more uniformly distributed and the tooth actually may be stronger. Since the strength of a gear tooth will depend upon the number of teeth for a given pitch, it will be necessary to determine the pitch for the smaller gear, provided the same material is used in both.

Load Is Distributed Equally

Case 2. With well made gears having accurate alignment, the load is assumed to be distributed equally over the whole face of the gear. As before, the load is carried by one pair of teeth.

Referring to Fig. 3, an equation involving the bending moment induced by the load W acting upon the arm h to the resistance offered at $l\ m\ n\ o$, or

$$W\,h = \frac{S\,b\,t^2}{6} \quad \text{.....(1)}$$

The following assumptions of tooth proportions will be made, namely, that $h = 2 \times$ addendum; t, for accurately made gears, equals one-half of circular pitch or $p'/2$; $b = X \times p'$ in which X may be given values from 2 to 4 to accord with average practice. The value assigned to the addendum varies in some gear systems and in the present case the addendum will be taken equal to the module or $1/P$, in which P is the diametral pitch or pitch number. Since the product of the pitches (circular and diametral) equals π, then $1/P = 0.32\ p'$ approximately.

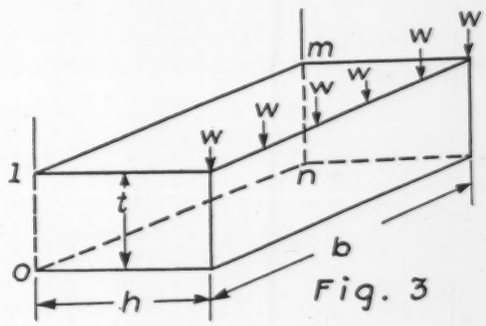


Fig. 3

Substituting these values in the general expression (1),

$$W \times 0.64\ p' = S\,X\,p'\ (0.5\ p')^2$$

which reduces to the form,

$$p' = \sqrt{\frac{15.4\,W}{S\,X}} \quad \text{.....(2)}$$

The derivation of a formula which may be applied to those gears in which the addendum or the tooth thickness differs from that in (2), can be effected easily by the substitution of the proper values in the fundamental expression (1). A gear tooth having an addendum equal to the module and based on a 14½ degree pressure angle is commonly accepted as "standard" and a gear tooth having an addendum less than the module is called a "stub" tooth.

A stub tooth usually is based on a pressure angle of 20 degrees or 22½ degrees. The "Fellows" system uses a 20 degree pressure angle and has an addendum which varies with the pitch but may be taken approximately at 0.8 of the module as an average value. Assuming this proportion for the addendum, the expression for the circular pitch will be

$$p' = \sqrt{\frac{12.3\,W}{S\,X}}$$

The circular pitch determined by the formula

refers to the lesser pitch number as given in the Fellows system of gear designation.

In a proposed stub tooth system of gearing, the addendum is taken 7/8 of the module and the pressure angle is 22½ degrees. Using these proportions, the expression for the circular pitch will be,

$$p' = \sqrt{\frac{13.44\,W}{S\,X}}$$

In all of the foregoing cases, the gear tooth was represented as a rectangular beam of the cantilever type with the load acting tangential to the addendum circle. To simulate the actual working conditions, certain modifications must be considered in the determination of a pitch which will be proper for a known load. The load or tooth pressure will act along the common normal or pressure line and the tangential component of this force must be considered as producing a turning action on the driven gear.

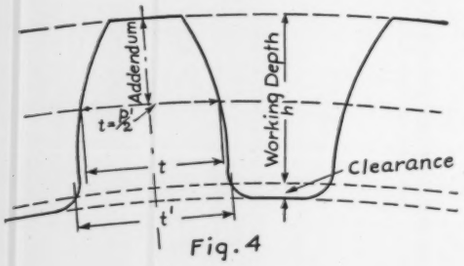


Fig. 4

In Fig. 1, let a c represent the normal force, then a d will be the tangential force and c d will be a radial force tending to separate the gears.

The actual form of a gear tooth will vary from that assumed in the derivation of the formula for the circular pitch, therefore a correction must be introduced to provide for the variation.

The working depth h determines the plane in which failure may be expected and an inspection of Figs. 4 and 5 shows that the value of t', the tooth thickness measured in this plane, may be greater or less than that of t, the tooth thickness measured on the pitch circle. With a uniformly distributed pressure acting on the addendum edge of the tooth, the relative strength of the actual tooth compared with one of a rectangular section varies as $(t'/t)^2$. For illustrative purposes, assume a 1 pitch gear for which the circular pitch is 3.14 inches and the tooth thickness measured on the pitch circle is 1.57 inches (backlash neglected). If the tooth thickness measured on the working depth circle is 1.35 inches, then $(1.35/1.57)^2$ or 0.74 represents the fraction of the strength of the given tooth compared to that of the rectangular form which was used in the derivation of the formula. From this condition it will be evident that the computed circular pitch must be increased in order to carry the load. Again, assume the tooth thickness measured on the working depth circle to be 1.78 inches, then $(1.78/1.57)^2 = 1.285$ or the assumed tooth is 28½ per cent stronger than the rectangular tooth. Therefore the circular pitch, as computed by the formula, is larger than will be required for the given load.

TABLE I

Correction Factors for Circular Pitch

Teeth in Gear Intervals	Involute		Cycloidal	
	14½	22½	12 Base	15 Base
12	1.14	1.00	1.12	1.33
13-14	1.10	0.96	1.08	1.19
15-16	1.07	0.92	1.04	1.10
17-18	1.04	0.88	1.00	1.03
19-21	1.01	0.84	0.96	0.98
22-24	0.98	0.80	0.92	0.95
25-29	0.95	0.76	0.88	0.92
30-36	0.92	0.73	0.85	0.89
37-48	0.88	0.70	0.82	0.86
49-72	0.84	0.68	0.79	0.83
73-144	0.80	0.66	0.76	0.80
145-Rack.	0.76	0.65	0.73	0.77

Finding Circular Pitch Value

Since the circular pitch varies inversely as the square root of the stress (S) it will be evident that if the computed pitch in each case be multiplied by the ratio of t/t', a suitably corrected value of p' (circular pitch) will be found. In order to apply a correction factor in any given case, the values given in Table I may be used.

The formulas presented will give a close approximation to the working strength of a gear tooth when the pitch and number of teeth are given, provided the working stress in the material of which the tooth is composed be known. Working stress is, however, such a variable factor that it is possible only to suggest limitations covering general conditions. The judgment of the designer, based on a knowledge of the conditions under which the gear is to work, must modify the general values as occasion may require. It is much more satisfactory to the designer to use a general formula involving a choice of stress than to employ an entirely empirical

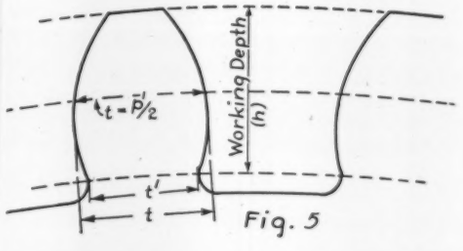


Fig. 5

rule in which the stress conditions may not be appropriate for a given case and which offers no opportunity for variation to accord with varying conditions.

Reuleaux, in his *Constructor*, states that the dimensions of gear wheels must, for the same pressure on the teeth, be increased to meet shock in proportion to the increase in initial velocity.

Flather in his *Transmission of Power* states that it cannot be doubted that slow speeds admit of higher working stresses than high speeds, but for teeth which are perfectly formed and spaced it is difficult to see how there can be a greater difference in strength than the well known difference occasioned by a live load or a dead load, or two to one in extreme cases. An important consideration which the designer must bear in mind in selecting a suitable value for the working fiber stress (S) is the possibility of serious consequences due to failure. Where the breaking of a tooth would result disastrously, it is evident that a low value of (S), or a better material must be employed; on the other hand cases will arise frequently in which the circumstances would indicate the use of a high stress with perfect safety.

While high rim speed does not necessarily imply shock, yet the effect of shock is more liable to be disastrous if high speed obtains and for this reason the stress should diminish as the speed increases.

The influence of change of load is well understood in engineering construction and usually a factor of safety is used to take care of such changes, the value depending largely upon the range of stress involved. There seems good reason to believe that a similar relation modified by the effect of speed should obtain in selecting a suitable value for the working stress in gear teeth. It would appear that the working fiber stress should be chosen both with reference to the linear velocity and to the character of the acting force.

Proposed Working Stress Formula

From the foregoing considerations, the following formula for working stress to be applied in gear design is proposed,

$$S = \frac{50000}{K + \sqrt[3]{V}}$$

In which, S = allowable stress in pounds per square inch, for cast iron. V = velocity of pitch point in feet per minute and K= constant having a value of 5 for steady load, 10 for variable load and 15 for violent shock effect.

From the formula given, the stress values which are shown in Table II have been calculated.

TABLE II

Values of Stress (S) for Cast Iron (Flather)

Velocity Ft. per. min.	Steady Load	Variable Load	Violent Shock
100	5200	3400	2550
200	4600	3140	2400
400	4050	2900	2250
600	3700	2700	2150
800	3500	2600	2050
1000	3300	2500	2000
1400	3100	2350	1900
1800	2900	2250	1840
2400	2700	2150	1770

For cast steel gears multiply above values by 2½.
For mild steel gears multiply above values by 3.

A further discussion on gear design will compare the foregoing method with that of Lewis.

"What Is Not Yet, May Be"

SIGNIFICANT of a half century of engineering progress, the Fiftieth Anniversary Medal of the American Society of Mechanical Engineers characterizes the spirit of the times in the inscription it bears, "What Is Not Yet, May Be."

The obverse side which is shown together with the reverse in the accompanying illustration, depicts the engineer symbolized by a man of powerful physique peering intensively past some typical measuring instruments into the future. These instruments are indicative of the fundamental function of technique, and plans held within his grasp disclose that his thoughts concerning the future are relative to achievement and progress. Inscribed in the block on which the figure leans is the commemorative phrase and below it a picturization of the Archimedean challenge which is the chief feature of the seal of the A. S. M. E.: "Give me where to stand and I will move the world." The past and present of engineering accomplishments illuminated by the lamp of knowledge which rests upon science and engineering are portrayed in bas-relief on the reverse side of the medal.

Fig. 1—Plane fitted with new diesel engine flying over open country

Aircraft Diesel Engine Embodies Striking Design Features

FURTHER conclusive proof that the diesel engine has taken its place in aircraft circles is furnished by the announcement that a diesel-powered plane flew recently from Detroit to Miami, non-stop. The distance was covered in ten hours, fifteen minutes, at a cost for fuel of $8.50. Furnace oil was burned.

The engine which made this and earlier performances possible was designed by Capt. M. L. Woolson, chief aeronautical engineer, Packard Motor Car Co. It is of the radial air-cooled type having nine cylinders with a bore of 4-13/16 inch and a stroke of 6 inches. The engine is rated at 225 horsepower at 1900 revolutions per minute and weighs 2.26 pounds per horsepower. Outwardly, as may be seen from Fig. 6, and in general characteristics it varies little from conventional gasoline engines of radial type, but it incorporates many features never before employed in aircraft engines, and of interest to all engineers engaged in design.

Describes Principle of Diesel Briefly

For the benefit of any still not conversant with the principle of the diesel, it should be mentioned that the ignition system is the radical departure from the more general Otto cycle engine; as against the electric spark depended upon to fire a combustible mixture of gasoline vapor and air in the latter, the diesel fires due to heat caused by compression of the air in the cylinder when the fuel, injected in a highly atomized condition prior to the piston reaching the top of its stroke, burns as it comes into contact with the heated air. Greatly increased pressures resulting from the tremendous increase in temperatures brought about by this combustion act on the piston to drive the engine in the usual way.

The fact that the air supply of a diesel engine is compressed and its temperature raised to such a high degree permits the use of liquid fuels with a high ignition temperature, and it is these fuels which correspond more nearly to the crude petroleum oil as it issues from the wells. This accounts for the low cost of diesel fuel.

Heretofore, in the so-called high-speed diesels of modern type the maximum speed has been limited to about 1200 revolutions per minute. The Packard engine speed however, has been increased to over 2000 revolutions per minute, and is capable of withstanding pressures considerably over 1200 pounds per square inch.

The crankcase, an aluminum alloy casting weighing only 34 pounds, is unique not only because it is of one piece thus dispensing with heavy flanges and bolts but also in respect to the novel fashion in which the cylinders are fastened to it. Ordinarily in a radial air-cooled engine each cylinder is held to the crankcase by a multiplicity of studs screwed into the crankcase flange and projecting through the cylinder flange against which the retaining nuts seat. With this arrangement the tension stresses resulting from the explosion loads in the cylinders are carried through the crankcase walls to the crankcase construction even with a gasoline engine. Such structure applied to the diesel would require the use of very thick sections since the light alloys used in crankcase construction have poor resistance properties for

The Packard Aircraft Diesel Engine

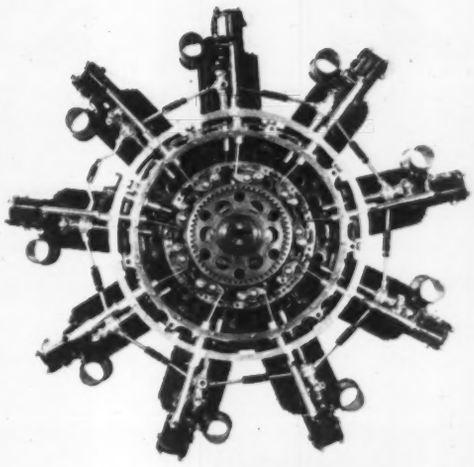


Fig. 2 (above)—Rear view of engine. Crankcase removed to show valve operating mechanism. Short connecting passages of fuel injection system may be seen

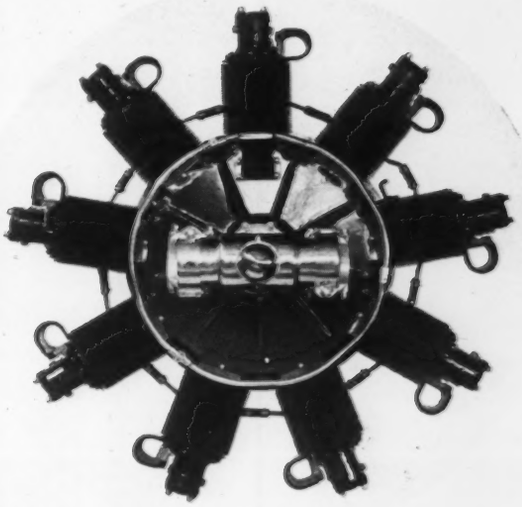


Fig. 5 (above)—Front view, showing one of the circular hoops of alloy steel around crankcase. These hoops are used to reduce stresses between cylinders and crankcase

Fig. 3 (center) — Capt. L. M. Woolson, designer, is at left and Walter Lees, pilot, at right.

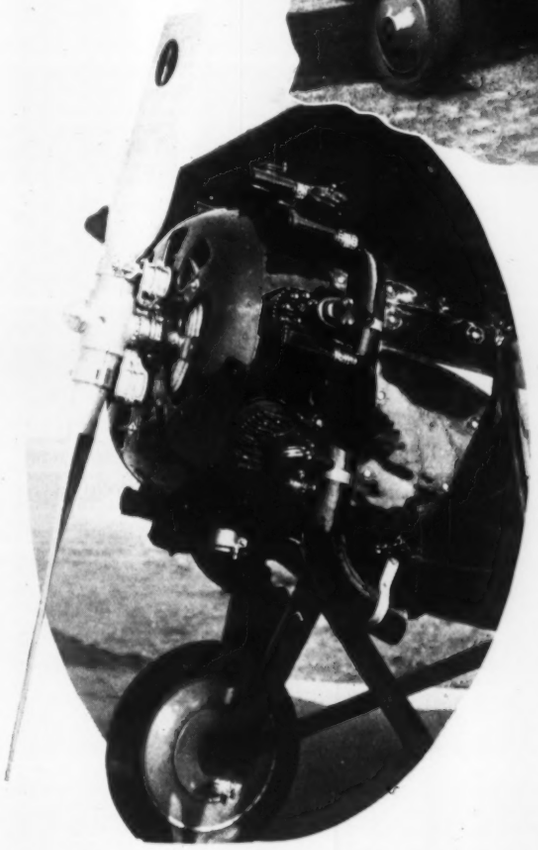
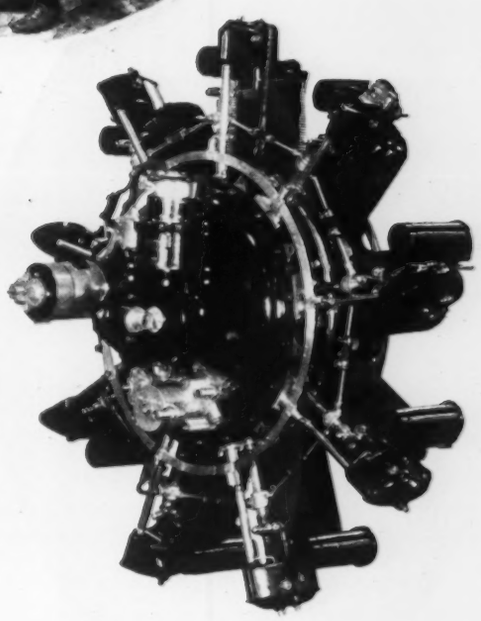


Fig. 4 (left) —General view of engine mounted in plane. Fig. 6 (right)—Rear view, showing equipment



this type of shock loading. To overcome this difficulty, two circular hoops of alloy steel encircle the cylinder flanges in contact with the crankcase at the front and rear of the engine, as shown in Fig. 5. These hoops are contracted by means of sturdy turnbuckles so that an initial stress is set up in the hoops. Under this system the crankcase is subjected to compression it is well adapted to resist. However, when the engine is running these stresses are materially reduced and at no time is it possible to transfer any tension loads from the cylinder to the crankcase.

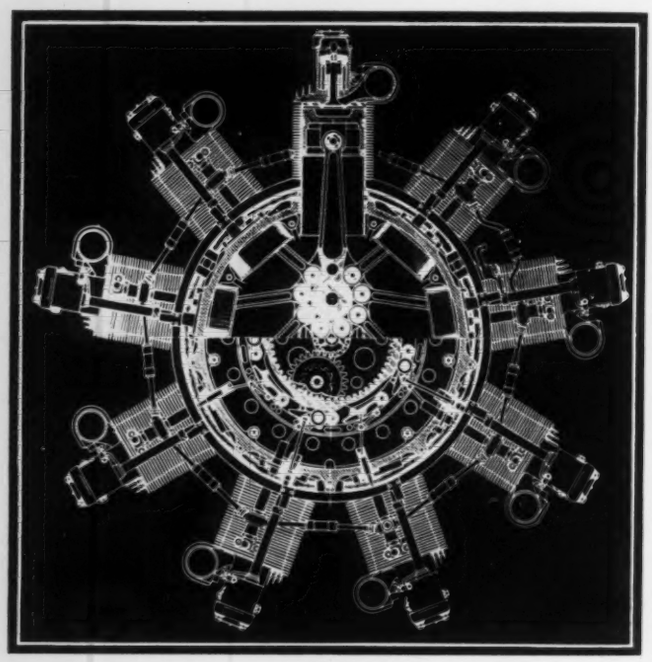


Fig. 7—Sectional view of engine

A Comparison May Be Drawn

Although the analogy is not strictly correct, a comparison may be made with an automobile wood wheel representing conventional aircraft engine crankcase construction, and a wire wheel representing the new Packard crankcase arrangement. The latter construction has proved considerably lighter because the load is not transferred from the ground to the hub directly through the lower spokes as is the case with the wood wheel but is spread over a great many more spokes arranged in the upper quadrant of the wheel. Those spokes in a wire wheel which are directly above the ground receive no load but rather have their initial tension reduced just as in the new engine that section of the crankcase immediately below the working cylinder has its loads reduced rather than increased at the time of explosion.

Maximum cylinder pressures are over ten times as great as average cylinder pressures during the working stroke. This would necessitate pistons, connecting rods, crankshaft and propeller being approximately ten times as strong as they would have to be to resist the average pressure were it not for the fact that effective measures have been taken to cushion these major parts of the engine from the shock loading. Advantage is taken of the fact that the peak explosion pressures exist only for a short time in each cycle. The crankshaft counterweights and the propeller are mounted flexibily on the crankshaft so that when the peak pressures occur a cushion is interposed between the crankshaft and those parts which have the maximum inertia or flywheel effect. Stresses in the crankshaft thus are greatly reduced and it is possible to use a crankshaft of a size not substantially different than that employed in a corresponding gasoline engine. Previously built diesels usually have been characterized by extremely heavy crankshafts.

Reduces Shock from Peak Load

Instead of being rigidly bolted to the crank cheeks the counterweights are pivoted on them and are located between powerful compression springs. When the crankshaft is suddenly accelerated the counterweights lag behind slightly so that the peak cylinder pressure is expended before the counterweights again are driven solidly by the crankshaft. Similarly the propeller hub instead of being splined or keyed to the crankshaft is allowed to float on an extension of the crankshaft driving end, and specially designed propeller-blade clamp rings provided with integral driving lugs receive the driving effort from a two-armed driving member splined to the crankshaft. See Fig. 8. On the extremity of each of these two arms a pair of rubber blocks is compressed between which the propeller clamp ring driving lug is secured. These blocks are confined in such a manner as to yield the desired elasticity. A marked weight saving is accomplished since the propeller hub can be made of light construction because it is completely cushioned from any driving shocks. While the elastic connection of the propeller to the crankshaft might in itself aggravate torsional vibration, the inherent damping or hysteresis of the rubber blocks, supplemented by the surface friction in the counterweight mounting, quickly and entirely smooths out the shaft rotation.

The single valve for outlet and exhaust operates at a much lower temperature than the conventional exhaust valve due to the cooling effect of the incoming air passing over it, and further-

more the available time for opening and closing the valve is lengthened appreciably so that lower rates of acceleration save wear and tear. Bolted to the top of each cylinder is a light aluminum cylinder head carrying cooling fins and supporting the valve operating mechanism as well as forming the combined inlet and exhaust port.

In a gasoline engine the mixing of fuel and air is accomplished in the carburetor, intake manifold, rotary distributor (if used) and finally in the cylinder itself during the intake and compression stroke. In the diesel engine no fuel is admitted into the cylinder until practically the instant combustion is desired. Thus it is obvious that in a high speed diesel special means must be provided to insure complete and efficient combustion. This has been accomplished by giving the incoming air an extremely rapid whirling motion so that at high speed the circulation of the air in the cylinder is at a rate which permits of one revolution of the mass of air around the circumference of the cylinder bore during the time available for combustion.

Solid fuel injection engines of the so-called high speed type (maximum revolutions about 1200 revolutions per minute) have been characterized by a multiple pump unit mounted on the engine remote from the cylinder heads in which the nozzles are located and connected to them by comparatively long capillary tubing. With such a system satisfactory high-speed operation is very difficult to obtain for several reasons, the principal one being that enormous hydraulic pressures necessary for high speed operation cause serious surges of pressure waves in the tubing. This interferes with the correct timing of the fuel injection and also tends to make the engine run unevenly since it is difficult to arrange the tubing to the various cylinders all of the same length. Another difficulty arises from the trapping of air in the capillary tubing. These troubles have been overcome with the Packard fuel injection system since the pump and nozzle are practically one unit with extremely short connecting passages between.

Valve and Fuel Pump Operation

The valve and fuel pump push rods of which there are nine each, all radially arranged at the rear of the engine, are operated by two cams which are driven at one-eighth engine speed in the direction opposite to the crankshaft rotation. Both the single valve and fuel pump of each cylinder are operated by rocker arms which contact with their respective cams. Outer ends of the short ball-ended push rods contact with plungers fitted in forged duraluminum guides.

The fuel pump body is an alloy steel forging fitted with a bronze cylinder. Ports are provided in the cylinder through which the fuel enters after passing through a fine mesh screen. Clamped between the pump body and the nozzle body is a ball check valve assembly which permits the fuel to flow to the nozzle and prevents any gases from the combustion chamber backing up into the fuel pump cylinder.

Multiple Valve Springs Used

As may be seen in Fig. 8, each valve is fitted with twelve valve springs of the multiple type used on various models of Packard aircraft engines. As an additional precaution a small wire circlip engages the valve stem above the valve guide and prevents the valve dropping into the cylinder from any cause whatsoever. The intent of this arrangement is not only to insure security from the failure of individual valve springs but also practically to eliminate the probability of such failures due to the fact that individual springs of this small diameter and light weight have high periods of natural vibration thus avoiding

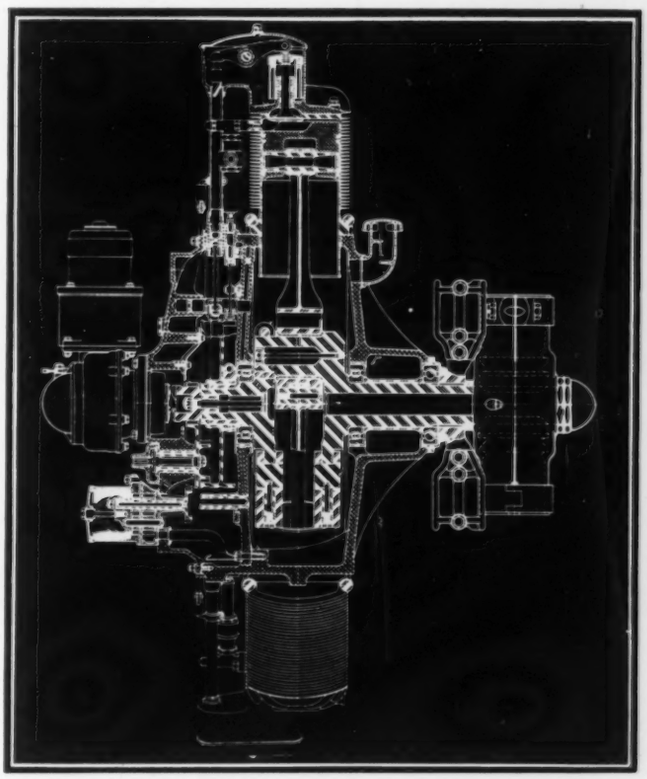


Fig. 8—Cross-section showing two-armed shock absorbing driving member for propeller

the danger of forced vibration. Furthermore, the small size of spring wire has superior physical properties as compared with the larger sizes used with the more conventional form of valve springs.

Recommends Standardized Practice for Line Drawings

PROPOSALS covering American recommended practice for the first of a series of standards prepared by the sectional committee on standardization of drawings and drafting room practice have been issued in tentative form. The proposals, covering line work, will be followed by others dealing with such subjects as lettering, methods of indicating bolt heads, nuts and screw threads, and dimensioning.

These proposed standards are being prepared under the auspices of the American Standards association and are sponsored by the American Society of Mechanical Engineers and the Society for the Promotion of Engineering Education.

In connection with the proposed practice for lettering drawings, it is interesting to note that whereas educational institutions favor inclined letters, the industries are in favor of vertical lettering. In the draft of the proposal, however, it is mentioned that "In making recommendations for a universal type of lettering, it seems desirable to be governed by the group which uses it in practice."

A selection of the more important recommendations covering line work are given on this and the following page. Comments will be welcomed by the American Standards association, 29 West Thirty-ninth street, New York.

Proposed Practice

Sectional views, or "sections," are used when the interior construction is more clearly shown than by outside views. The view is made in sections as if part of the object were broken or cut away and removed. The exposed cut surface of the material is indicated by "section lining" or "cross hatching."

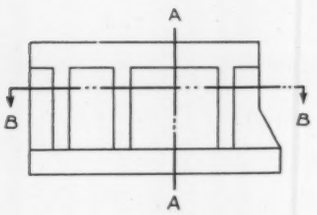


Fig. 1

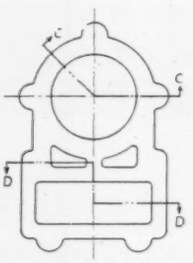


Fig. 2

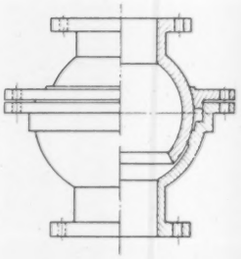


Fig. 3

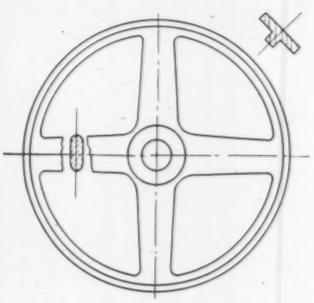


Fig. 4

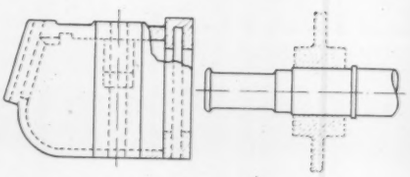


Fig. 5 *Fig.* 6

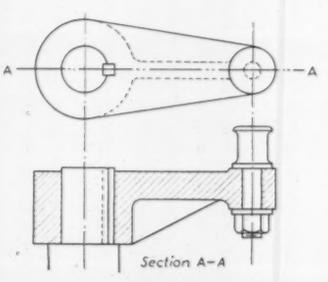


Fig. 7

The general rules for projections apply to sectional views. Invisible or hidden lines beyond cutting plane usually are not shown. To insure clearness, such detail not required in explaining the object may be omitted. It is not necessary that the cutting plane be a single continuous plane but may be bent or offset to best show the construction.

When it is necessary to indicate where a section has been taken, a very heavy broken line should be used, consisting of one long and two short dashes alternately spaced. The section letters are used at each end of the line as shown at *AA*, Fig. 1. Arrows may be used to indicate in which direction the section is viewed, as shown at *BB*, Fig. 1, section letters being placed at the points of the arrows.

When parts of a section are taken at different angles or in different planes, the cutting plane line is turned at the proper points, as Section *CC* and Section *DD*, Fig. 2. Cutting planes may be indicated by omitting the extra heavy lines, except for about a quarter or half inch at the ends and where the plane changes.

"Half sections" are a convenient way of showing objects which are symmetrical about a center line. One half is drawn in full; the other half in section. See Fig. 3.

Other Section Forms

"Turned sections" are used to show the shape of some details, such as a rib or the arms of a wheel. The cutting plane is passed perpendicular to the surface and revolved in place, or the section may be moved to one side, as in Fig. 4.

"Broken-out sections" are used where a section of only a portion of the object is needed. See Fig. 5.

"Phantom sections" of "Dotted sections" are outside views with the in-

terior construction shown by dotted cross hatchings, consisting of short dashes. This may save an extra view, as indicated in Fig. 5. The term "Phantom section" is used when showing the adjoining section of an absent part, as in Fig. 6.

When the section plane passes through a rib, web or similar structure to which it is parallel, section lines should be omitted, as shown in Section *AA*, Fig. 7. Shafts, bolts, nuts, rods, rivets, keys, pins and similar parts which occur in the cutting plane are not sectioned but shown in elevation. The section is drawn as though the plane passed around the shaft, bolts, etc., and to one side of the rib or web. This conventional method gives a clear idea of the section.

Violations of theory often may be tolerated in the interest of clearness.

In drawing an unsymmetrical piece, the sectional view and side view may be made symmetrical as though the ribs were rotated into the plans of the section or projection. The section Fig. 8 and view Fig. 9 are preferred rather than the true projection of the ribs. Drilled flanges in elevation or section should show the holes at their true distance from the center, rather than as projected. See Figs. 8 and 9.

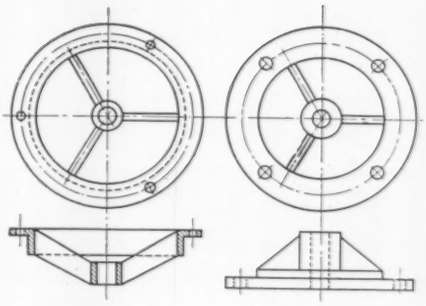


Fig. 8

Fig. 9

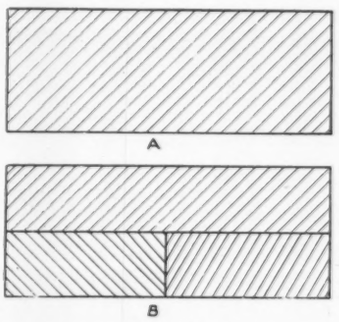


Fig. 10

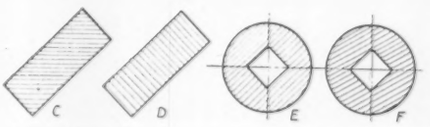


Fig. 11

Fig. 12

Line Sectioning

Where parallel lines are used for cross sectioning, they should be made at an angle of 45 degrees to border line of the drawing, spaced from about 1/16 to 1/8-inch apart. When more than two parts of the same material appear, adjacent in one section, two of the parts are sectioned with 45 degree section lines, while the third is sectioned at 30 or 60 degrees as in Fig. 10*B*. In one view the sectioning of one part should all be in the same direction even if cut in more than one place.

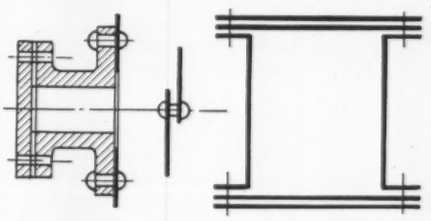


Fig. 13

To avoid confusion, section lines may have to be made at other angles than 45 degrees on account of the shape of the part or section. In *D*, Fig. 11, with sectioning at 45 degrees, the part appears as a gear and it is preferable to make the section lines horizontal, or at 45 degrees to the outline of the part, as shown at *C*.

At *E*, Fig. 12, sectioning parallel to the edge of the hole is confusing and should be made at 30 or 60 degrees as in *F*. In general, section lines should not be parallel to the side of the part being sectioned.

Sections which are too thin for line sectioning may be shown solid, such as structural shapes, sheet metal, packing, gaskets, etc. Where two or more thicknesses are shown there should be a white line between, as in Fig. 13.

Symbols for Materials

The symbols and cross-sections shown in Fig. 14 give a conventional method of distinguishing various materials commonly used, but can only indicate the general character and not complete specification of the material of the parts. They permit of sub-division if found desirable, by making minor changes but maintaining the general characteristics.

For simplicity on details where the material is named, sections may be shaded or made as for cast iron.

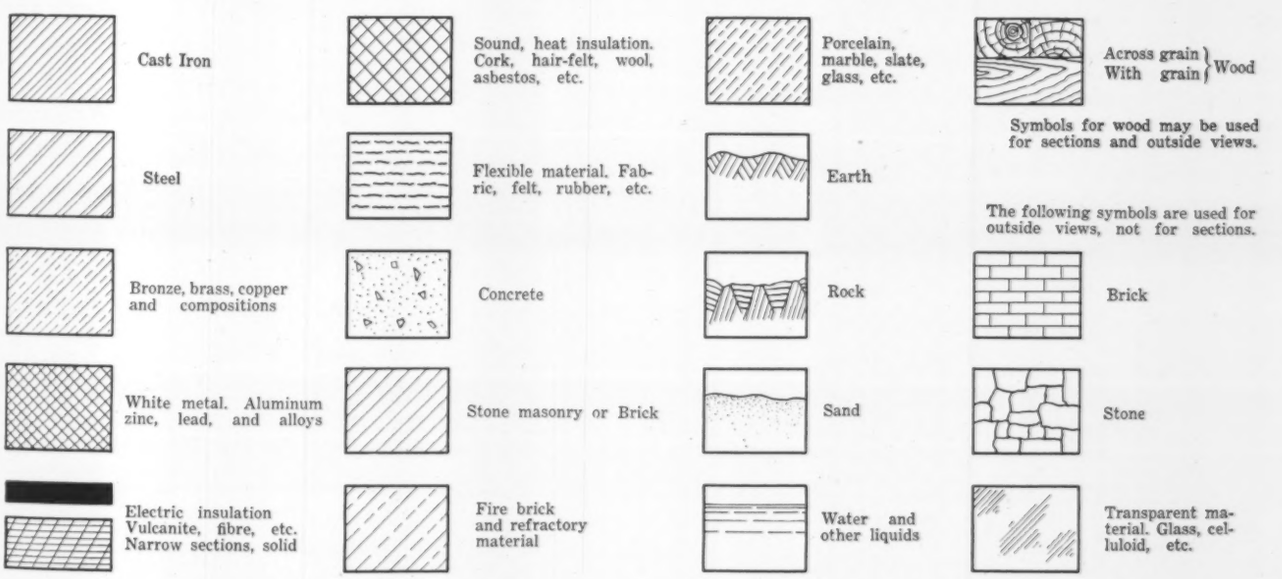

Cast Iron
Steel
Bronze, brass, copper and compositions
White metal. Aluminum zinc, lead, and alloys
Electric insulation Vulcanite, fibre, etc. Narrow sections, solid
Sound, heat insulation. Cork, hair-felt, wool, asbestos, etc.
Flexible material. Fabric, felt, rubber, etc.
Concrete
Stone masonry or Brick
Fire brick and refractory material
Porcelain, marble, slate, glass, etc.
Earth
Rock
Sand
Water and other liquids
Across grain
With grain
Wood
Symbols for wood may be used for sections and outside views.
The following symbols are used for outside views, not for sections.
Brick
Stone
Transparent material. Glass, celluloid, etc.

Fig. 14—*Symbols and cross-sections employed for indicating materials of various descriptions*

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Hydraulics Valuable Aid to Design

To the Editor:

I HAVE just finished reading the first article published in the March issue of your magazine on the subject of hydraulic transmission. It is extremely valuable and I am anxiously awaiting the following installment. I have appreciated for several years the many advantages offered by the introduction of hydraulic transmission to heavy mobile machinery and have devoted a great deal of time to the study of the subject and how it might be applied. In fact, I have at the present time a patent pending on a completely hydraulically operated power shovel and another patent pending on the hydraulic principle applied to the propulsion of airplanes. The former application offers simplicity and power wherever reversing motions are required such as for crowding, swinging and traveling, and in the airplane offers the advantage of a comparatively small central power plant located to the best advantage in the plane with the possibility of attaching as many propellers thereto as desired and not restricting their position.

The subject of the article was a very pertinent one and which, I believe, will be welcomed by many engineers in various lines of industry. It represents the last known source of power transmission that has not been thoroughly exploited and developed.

—J. D. RAUCH,
Lima, O.

Geneva Wheel Is Ideal Indexer

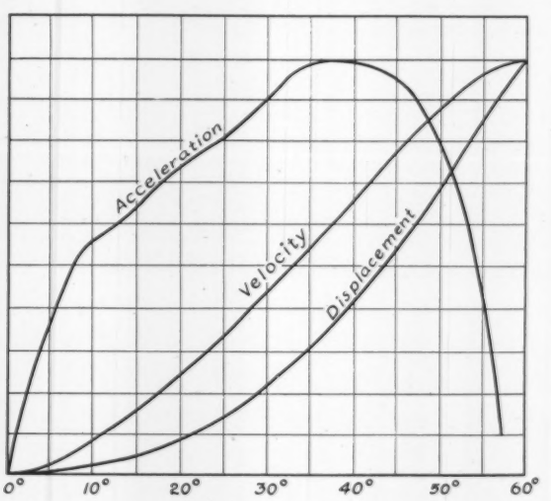
UNDER advantages of the geneva wheel, Mr. Chapman makes the following statements in his article on page 37 of MACHINE DESIGN for March.

"Acceleration, which is gradual from a state of rest to maximum when movement is half completed, from which point it decreases and becomes gradual as the movement is ended. This will be noted in Fig. 2."

In my opinion this statement is misleading, the maximum velocity of the wheel occurring when half the stroke is completed, i.e. when the roller is on a line joining the centers of the wheel and driving arm. This however, is no indication that the point of maximum acceleration coincides with the point of maximum velocity, as acceleration is the rate of change of velocity.

The curve referred to in Fig. 3 in the original article was a displacement curve. In order to see how the acceleration varies a velocity curve may be drawn. To demonstrate I have plotted the displacement, velocity and tangential acceleration curves for one half the motion of a six slot geneva wheel.

The displacement curve is plotted from the data given by Mr. Chapman. Points along the base line represent the motion of the driving arm in degrees, points along the vertical axis represent



the corresponding motion of the geneva wheel.

Velocity curve. Assuming the driving arm has a uniform angular velocity. Points along the

base line represent equal intervals of time. Points along the vertical axis represent the velocity of the wheel. This curve is plotted from the data given by the displacement curve.

Acceleration curve. Points along the base line represent equal intervals of time. Points along the vertical axis represent the angular acceleration of the wheel. This curve is plotted from the data given by the velocity curve.

These curves show that the velocity is maximum when the stroke is half completed and the acceleration is maximum when the arm has moved about 37 degrees (actually 37 degrees 6 minutes).

I have not assigned any particular values for the curves as the speed of the driving arm will not affect their character.

—S. B. St. John,
Bridgeport, Conn.

Is A Bonus System Possible?

Editor's Note: *Touching upon a timely subject, the following inquiry and an answer furnished by an authority on engineering department management are published for the interest and consideration of our readers. It is anticipated that those who have had experience in the feasibility of such a system, will be prompted to send in their comments.*

The Question:

To The Editor:

DO YOU have any information and data which outlines a bonus system of compensation to be applied to drafting rooms?

Our company is engaged in the manufacture of material handling machinery and virtually all of the propositions undertaken by the company must be engineered. This includes making a complete set of drawings to be used in the field for construction and erection and also the detailing of a large part of the machinery, particularly the support, for fabrication in our shops.

—Chief Engineer.

The Answer:

To The Editor:

I AM SORRY I have no knowledge of a bonus system for draftsmen, and personally do not think it practical. On design work it obviously is impossible, for what you are purchasing of the draftsman are not lines on a drawing sheet, but economic engineering ideas. In an organization in which each "design" was about 90 per cent similar to a predecessor, and for purely "selling" reasons the standard items or similar items were not called for by part number, but were redrawn with the customer's name on them, a bonus might be used. Such a system of redrawing parts is subterfuge and not good design management. In case of changes, the arguments between the draftsman and the engineer, due to the effect of changes on bonus earning possibilities, would far outweigh the advantages.

—John F. Hardecker,
Philadelphia.

Should It Be Draftsman or Ingenieur?

To the Editor:

I HAVE read "Old Draftsman's" interesting contribution, "Should it be Draftsman or Ingenieur?" which appeared on page 47 of your March issue.

We might say something clever about a rose smelling just as sweet if known by any other name, but the fact remains that the term "Draftsman" implies somewhat of an odium. The most promising members of the coming engineering generation hesitate to view design as a career because they do not care to become draftsmen; some employers have the habit of regarding a draftsman as a labor commodity, not quite on a par with a good machinist.

We are decidedly in need of a new word that would differentiate between a designing draftsman and a tracer or detailer. The term "Engineer," as "An Old Draftsman" points out, is ambiguous; the term "Designer," pure and simple, somehow suggests the argument about the length of ladies' dresses.

We need to strike out for something entirely new, just as the real estate men did a few years ago. They found an odium attached to the term "Real Estate Man," and, probably with the advice of some philologist, they devised the word "Realtor." The word is really very cleverly devised. "Real" is related to regal, which means royal. "Tor" is the same thing we have in Toreador, "Toro" meaning bull. Hence, "Realtor," royal bull.

Could not we engineers devise something as smart as this?

—J. F.

MACHINE DESIGN

Now Style Is Patentable

Editorial

WHILE an ever increasing number of design engineers realize the importance of attractive appearance as a sales point in the merchandising of machines, it has remained for the United States Court of Customs and Patent Appeals to give official recognition of this tendency. A recent decision of the court means in effect that distinctive features of style and appearance can be patented independently of the mechanical design of a machine.

THE case grew out of an appeal by the president of a company engaged in the manufacture of concrete mixers. The company sought to patent the design of a truck body and frame for a concrete mixing machine in which the various parts were arranged so that the entire assembly presented a distinctly pleasing appearance.

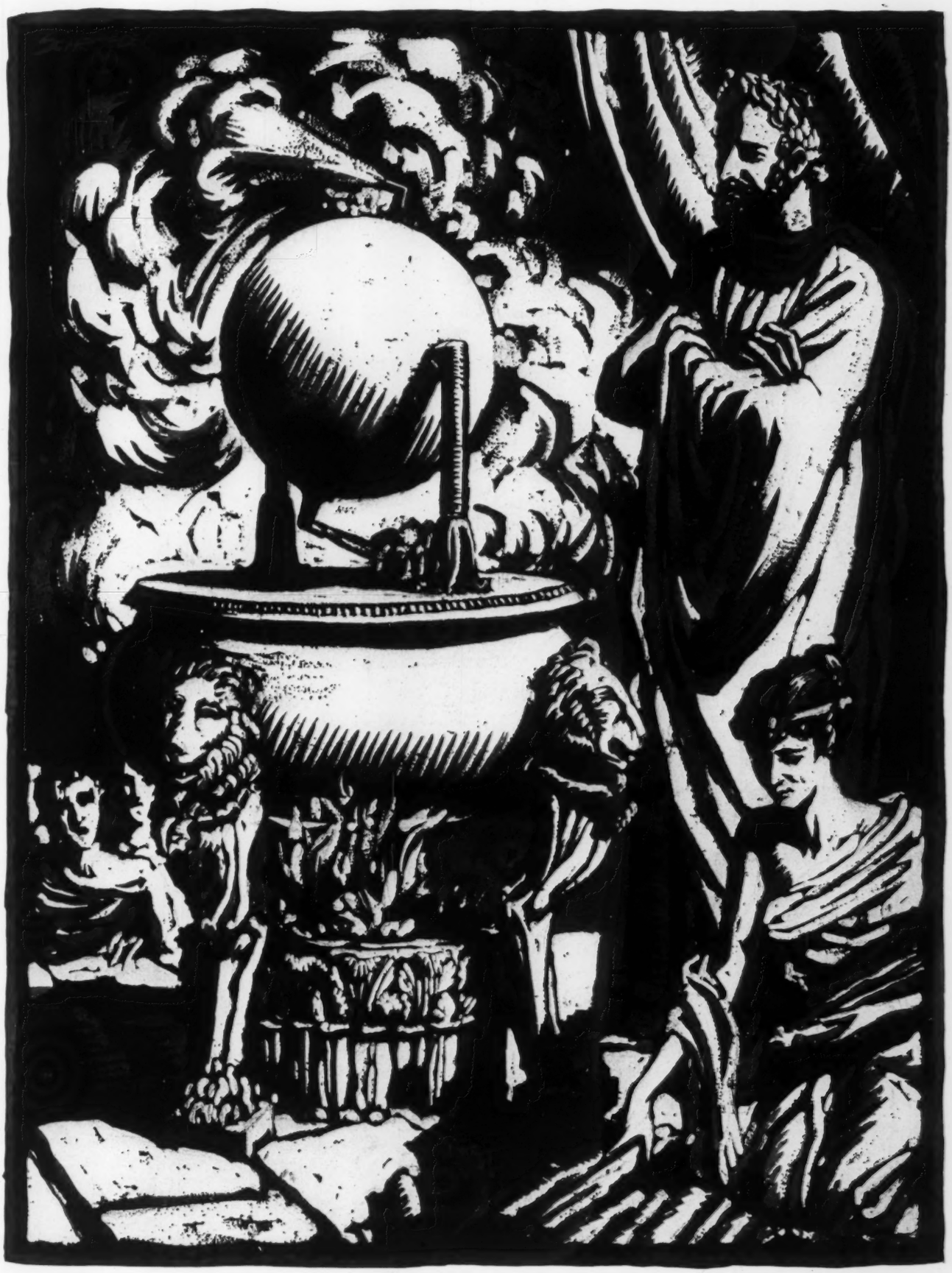
TWO court members, in a dissenting opinion, said: "It has escaped our observation if the pulchritude of articles like concrete mixers has ever exerted any great public consideration." But the opinion in which the majority of the court concurred, held that the appellant had produced "by plan of assembly . . . . into a compact and more symmetrical whole, an article possessing more grace and pleasing appearance than existed in the prior art," and added: "In this mechanical age . . . . it is certainly not undesirable that some of the unsightliness of such contrivances be eliminated, if possible. To conclude that Congress, in the enactment of the design patent law, had such a result in contemplation is not unreasonable, since such a purpose is in entire harmony with the declared aim of the legislature."

WITHOUT attempting to appraise the value of this decision in supporting or stimulating the development of esthetic design, we believe it will be welcomed by manufacturers who are trying to co-ordinate good mechanical design with other features to increase the salability of their machines. Almost daily evidence is available of the growing interest among engineers in beauty, ornamentation and other qualities beyond the scope of pure mechanics. The tendency in this direction is likely to become more and more pronounced, and as the emphasis placed on style and appearance increases the pressure for patent office protection on these features will be accentuated. For these reasons the court's decision is both timely and significant.

Machinery on the Farm

HIDDEN between the lines of J. Brownlee Davidson's article in this issue on the design of agricultural machinery is an intensely interesting romance of American development. When the early homeseekers first crossed the Mississippi, one man with wooden plow, sickle and flail had to put in the equivalent of a week's work to obtain 20 bushels of wheat on an acre of land. Today, thanks to the efficacy of machinery, a three-plow Montana wheat farmer single-handed with tractor, plow, drill, weeder, harrow, disk, truck, combine harvester, fanning mill and tools can operate 600 acres, netting a crop each year from 400 acres at a total cost of $16.50 per acre.

IT WAS improved farm machinery, as much as any other factor, which in the period from 1870 to 1920 made America the world's premier provisioner. And it will be modern machinery, coupled with a more business-like operation of farms, which in the end will lead to the rehabilitation of American agriculture. Once the economic factors affecting the distribution and consumption of farm products have been restored to proper balance, agriculture will again move forward at accelerated pace. And when that time comes, everything that designers have accomplished in mechanization, will yield big returns to farmers.



Hero and His Reaction Steam Turbine

Great Moments in Machine Design—Eighth of a series of original drawings prepared exclusively for this magazine symbolizing the designer's contributions to the progress of mankind

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining To Design

IMPROVEMENT in crank mechanisms to provide a driving medium or shaft which in the course of one revolution will impart a plurality of reciprocating movements is accomplished by John Dawson in his invention for which patent No. 1,748,443 recently was granted. Dawson Reciprocating Crank Actions Ltd., Toronto, Ont., is the assignee.

A movable center is provided to form the natural path for contacts across the face of a rotary member. The improved mechanism embodies a drive shaft, a connecting rod and means associated with the drive shaft for automatically imparting to a rod a plurality of reciprocating movements in an even plane simultaneously with a single revolution of the drive shaft. In the accompanying illustrations, Fig. 1 shows a sectional view of the mechanism as applied to a pump. The pistons 26 and 27 are attached to the connecting rod 15 with the result that in operation two reciprocating movements are imparted to each of the pump pistons during a single rotation of the shaft 10.

A drive shaft 10 carries driving plates 11 and 12, on the inner faces of which are formed semi-elliptical continuous guideways 13 and 14. The plates are so arranged that these guideways are opposite and at right angles to one another. Connecting rod 15 extends between the two plates 11 and 12 as shown in Fig. 2, and is centrally U-shaped at 16 to clear the drive shaft 10. This rod is provided with rigidly mounted roller engaging members 17 and 18, one protruding on each side and longitudinally spaced to engage simultaneously with the opposing trammels in each of the plates 11 and 12.

Significant in this invention is the fact that while one contact is in engagement with the driving medium at a distance from the central source of power, the other contact, engaging simultaneously with the other driving medium, will be close up to or at substantially the center of the source of power. In this way, the inventor claims, the loss of power is obviated and a balanced distribution maintained that could not possibly be provided with existing constructions.

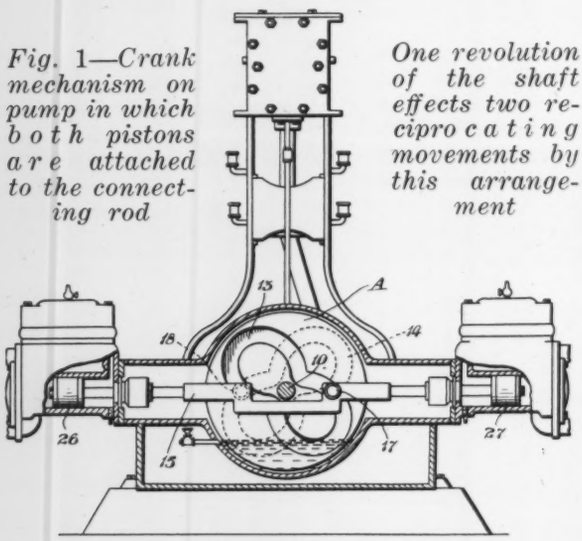


Fig. 1—Crank mechanism on pump in which both pistons are attached to the connecting rod

One revolution of the shaft effects two reciprocating movements by this arrangement

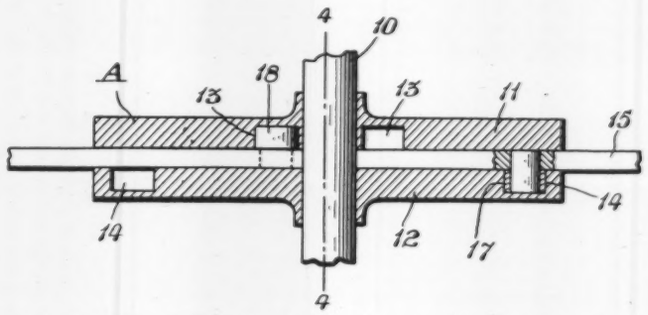
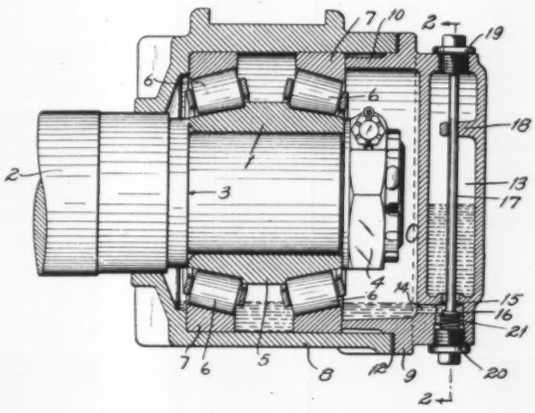


Fig. 2—Semi-elliptical guideways are formed on the inner faces of driving plates indicated by 11 *and* 12

LUBRICATION of railway axles and particularly axles equipped with roller bearings, is the object of an invention of Oscar J. Horger who recently was granted patent No. 1,745,216. Timken Roller Bearing Co., Canton, O., is the assignee. The chief aim of the invention is to maintain a fluid lubricant at a reasonably constant level so long as the supply lasts. Another object is to provide an ample supply reservoir suitably arranged and adapted for automatically feeding the lubricant.

In construction the invention consists principally of a closure cap in the form of a reservoir

of considerable capacity with a passageway leading from the lower part to the bearing. The accompanying illustration shows the end portion



Hollow closure cap constitutes oil reservoir which supplies lubricant to bearings as needed

of an axle in elevation and also shows in longitudinal section a roller bearing mounted thereon, including the housing and the closure of the bearing.

As illustrated in the drawing, an inner raceway member 1 is mounted on the axle 2 near the end, the inner end bearing positioned against a shoulder 3 in the axle and held in place by a nut 4 mounted on the end of the axle. Co-operating with bearing surfaces is a circular series of taper rollers 6 that also co-operate with cups 7 or other raceway members that are seated in a suitable housing 8.

According to the inventor, the closure cap is hollow to constitute an airtight chamber or reservoir 13 for the lubricant. In adapting it for lubricating purposes, a hole or passageway 14 extends from the hollow interior to the inner face of the cap slightly below the level at which it is desired to maintain the lubricant in the bearings. As seen in the construction illustrated, this hole has a horizontal portion extending from the inner face of the closure cap and communicating with a vertical portion which in turn opens into the hollow chamber that constitutes the oil reservoir.

Forms Valve Seat

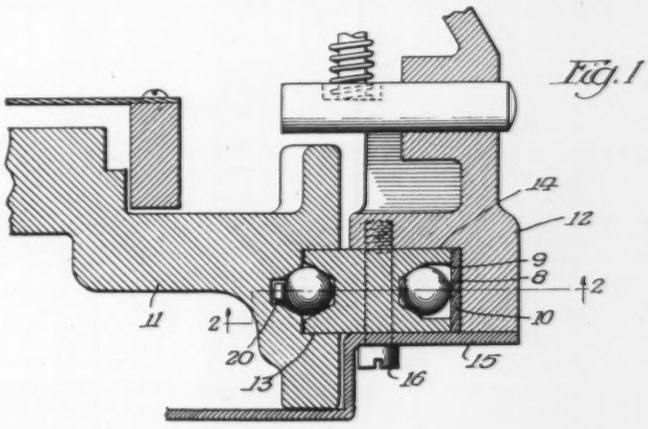
The beveled end of this vertical portion forms a valve seat 15 for a valve 16, the stem 17 of which extends upwardly through the reservoir. A nut or plug 19 closes a threaded hole in the top of the closure cap and a second nut or plug 20 closes a threaded hole in the bottom of the cup, which also serves as a lower abutment for a coiled spring 21. Parts are arranged and adjusted so that when the top plug 19 is removed, the spring 21 will lift the valve 16 against the seat 15 and thereby shut off communication between the oil reservoir and the interior of the housing. When, in the course of use, the level of the lubricant in the housing falls, air finds its way into the reservoir and such amount of lubricant as may be necessary to restore the level in the housing passes from the reservoir.

AN INVENTION relating to antifriction bearings of simple construction has been patented by Herbert L. Thompson, Elgin, Ill., and assigned to Addressograph Co., Chicago. The patent number is 1,750,140. Among the objects of the invention is the provision of a wedge-shaped ball bearing adapted to be adjusted easily and accurately in fixed position between two parts, one of which is movable relative to the other part.

Lateral thrust is said to be prevented by the use of this bearing unit and the movable part is maintained in proper relation to the stationary section of the machine. Applications include printing machines and many other units having similar arrangements incorporating movable parts. Fig. 1 is a sectional view showing the invention applied to a printing machine between the movable carriage and the frame upon which it travels. A horizontal sectional view of the bearing is shown in Fig. 2 on page 50.

Provided with Race

As shown in the accompanying illustrations, 6 is the body of the bearing provided with a race 7 to receive the balls 8. The body is elongated and tapered from end to end to make it wedge shape. The top and bottom walls are cut away on one side so that the balls will project. Bent around the ends and the outer side of the body to retain the balls in the race is a retainer strip or shield 10. At the ends, however, the retainer terminates with the bends so that the balls travel-



Application of antifriction bearing between movable carriage and frame of printing machine

ing in a straight line on the inner side of the bearing will be free and unrestrained.

In Fig. 1 the bearing is shown interposed between fixed frame 11 and movable carriage 12, the frame having a guide groove 13 in which the bearing slides. The carriage has a recess 14 in which the bearing is secured by a plate 15 and screws 16. Wall 17 of the recess is inclined. The body of the bearing is provided with slots

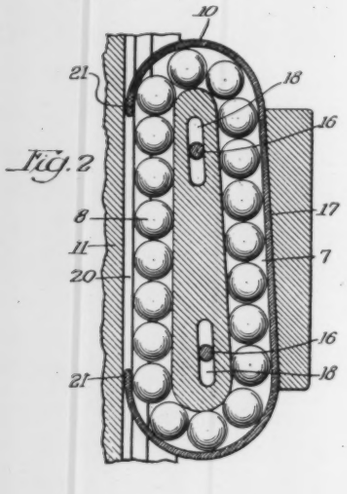


Fig. 2

Sectional view of the wedge-shaped ball bearing showing slots to receive adjusting screws

18 to receive the screws 16, thereby facilitating easy and accurate adjustment of the bearing in proper position between the fixed and movable parts of the machine. This arrangement provides a significant feature of the invention and enables the movable part to operate without binding or seizing in the groove.

The back wall of the groove 13 in the fixed part is provided with a slot 20 in which the ends 21 of the shield 10 ride, thereby allowing the balls between the retainer ends to contact directly with the back wall of the groove. Figs. 1 and 2 show this. According to the inventor the wedge shape construction is desirable because it enables an accurate adjustment and a long engagement between the bearing and the wall of the movable member in which it is secured.

Review of Noteworthy Patents

Other patents pertaining to design are briefly described as follows:

VALVE—1,733,204 for "a valve comprising a casing having an outlet opening surrounded by a valve seat, the wall of the casing opposite the valve seat having an opening, a member fitted to and closing the last mentioned opening and incorporating a tubular guide, a stem reciprocable within said guide, a valve member carried by the inner end of said stem for co-operation with the valve seat, an actuator for reciprocating the valve stem, and a resilient element in the connection between the actuator and the valve member." Assigned to Perfection Stove Co., Cleveland.

HYDRAULIC GOVERNOR—1,748,506. The mechanism covered by this patent comprises in part a governor for a machine, the combination with a driving element of the machine, fluid controlled means to actuate the device, a pilot valve casing, a pilot valve mechanism comprising a valve and a free-floating valve sleeve movable relatively one to another and both mechanically independent of the actuating means adapted to operate the valve sleeve. The pilot valve is actuated by a driving element and the casing is provided with a working fluid pressure port and channels for passage of working fluid to the actuating means of the controlling device. Assigned to DeLaval Steam Turbine Co., Trenton, N. J.

LET-OFF MECHANISM—1,749,131. "For a loom having two warp beams comprising a positively rotated let-off member, a hand wheel rotatable with the let-off member, manually controlled means for connecting and disconnecting the let-off member and hand wheel, differential driving connections between the hand wheel and both beams whereby the tension on the warp on both beams is continuously equalized, and means to vary the amount of said rotation of the let-off member in proportion both to the warp tension and to the amount of yarn on the beams of each pick." Assigned to Draper Corp., Hopedale, Mass.

GEAR CASE—1,748,521. This patent covers "the combination with a driving rotatable element, a driven rotatable element movable bodily toward and from the driving element, and a train of gears operatively connecting the elements, of a case housing the elements and said gears and having a slot in one side through which the driven element passes, an elliptical rib on the inner surface of the slotted side of the case coincident with the slot, and a sealing plate carried by the driven element and extending entirely over and slidably resting on the inner edge of the rib." Assigned to New Idea Spreader Co., Coldwater, O.

LEVER—1,748,690. "A lever comprising two separable similar body portions arranged back to back throughout the major portions of their length and provided at one end with diverging face portions having aligned openings for receiving a rod." The body portions have registering longitudinally extending slots opening into the openings. Means for holding the body portions in assembled position include clips having portions embracing the longitudinal edges. Assigned to Kales Stamping Co., Detroit.

PUMP—1,749,212. Covered by this patent are "a plurality of pairs of speed aligned cylinders, a scotch yoke disposed between the opposed spaced ends of each pair of cylinders and having opposed arcuate slideways, complimentary slides fitting in the slideways, a crank for actuating the slides, a reciprocable piston in each of the cylinders, and means connecting each of the pistons with its associated yoke." Assigned to Continental Gin Co.

CHECK OR GLOBE VALVE—1,733,276 for "a valve assembly comprising a valve body having a central valve chamber and a lateral aperture extending through the wall of said body into said chamber, a seat sleeve unit having a central aperture therethrough tightly fitted into the lateral aperture in said valve body, a valve seat surrounding said aperture, swing check valve adapted

to co-operate with said valve seat and seal the opening through said aperture and a hub unit having a plurality of hub members embracing said body and tightly shrunk thereon so as to have fluid tight engagement therewith." Assigned to the Columbus Machine Co., Columbus, O.

TRANSMISSION—1,749,099. Comprising this device is a transmission housing having a cover, a shift rod extended through the cover, the rod having a ball and socket connection through the cover, a coiled spring encircling the shift rod within the cover, a gasket member wieldingly urged by the spring to form a liquid tight joint, and a washer having an open side adapted to engage the shift rod and to be engaged by the spring to place the gasket and the ball and socket connection between the rod and cover under spring pressure. The washer is readily detachable from the rod by depressing the spring and moving the pressure washer laterally. Assigned to Ford Motor Co., Dearborn, Mich.

ELECTRIC SWITCH—1,748,905. "In an electric switch of the liquid break type, a fixed contact, a co-operating movable contact, and an explosion chamber enclosing the fixed contact and having an opening therein for receiving the movable contact, said chamber having the body portion thereof constructed of a single piece of ceramic material. Assigned to General Electric Co., Schenectady, N. Y.

SPIRAL BEVEL GEAR—1,748,813. This patent covers a pair of spiral bevel gears, each of which have tooth spaces whose sides and bottoms are conjugate to, but different from, coaxial surfaces of revolution, the surfaces being of such diameter that the sum of the dendum angles of the pair is substantially the same on the large end and on the small end of the teeth. Assigned to Gleason Works, Rochester, N. Y.

NEEDLE-BAR MECHANISM—1,748,709. "In a sewing machine, the combination with a loop-taker, and a plurality of needle-bars each carrying a needle." In addition to these there is a needle-bar operating rock shaft, a plurality of cranks on the rock shaft and a link connection between each of the cranks. Radii of the cranks form an acute angle. Assigned to Singer Manufacturing Co., Elizabeth, N. J.

MOTOR VEHICLE—1,748,702. Details of this invention include in combination, a pair of shafts, a universal joint coupling the shafts together, means for excluding dirt from the joint, and yielding means drawing a flexible cover inwardly. Assigned to Chrysler Corp., Highland Park, Mich.

CRUSHER—1,748,828. Included in this invention is the combination of a crusher member, a bearing for the member, and means extending from the crusher unit so as to enclose, at least partially, said bearing. Assigned to American Engineering Co., Philadelphia.

AUTOMOTIVE BRAKE DEVICE—1,733,186, consisting in part of a brake drum and brake head mounted therein. A cylinder is mounted in the drum and a piston rod extends out of the cylinder, one end of the piston rod being engaged with a pivoted lever. An adjustable cam carried by the brake head engages the lever at a point intermediate the pivot connection and the piston rod. Assigned to Westinghouse Air Brake Co., Wilmerding, Pa.

Aluminum Alloy Strength Is Selection Factor

(*Concluded from Page* 26)

used with wrought aluminum-manganese alloy (3S) pipe and tubing in order to reduce the tendency towards electrolytic corrosion.

The exceptional properties of No. 195 alloy are realized only after a solution heat treatment, or a solution heat treatment followed by a precipitation or aging treatment. Alloy 195-4 is used where maximum shock resisting properties combined with high strength are required. The yield point increases substantially with some increase in strength and decrease in elongation on standing at ordinary room temperatures. Alloy 195-16 has a higher tensile strength, yield point and hardness than No. 195-4 but a lower elongation. The elongation is sufficient, however, to make this alloy capable of withstanding the shocks and abuse of general service. In alloy 195-10, the hardness, yield point and tensile strength are carried to the highest point consistent with the avoidance of excessive brittleness.

Alloy No. 122 gives castings which offer considerable resistance to wear and retain their physical properties quite well at elevated temperatures. This alloy is used for valve guides, cam shaft bearings and for internal combustion motor pistons.

New Use for Roller Bearings

A new field for roller bearings is seen in their application to 70-ton capacity, Pennsylvania railroad hopper cars used in the transportation of coal. This is believed to be the first application of roller bearings to coal cars in the history of railroading. The cars recently equipped will be assembled into a train and put through test runs under varying conditions of temperature, grade and speed. These experiments will determine the comparative resistance of roller bearing cars with the standard type now in use on the Pennsylvania railroad.

Annual Report Shows Record Year

As shown by its annual report, made public recently, sales billed, orders booked, and net income of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., for the year ending December 31, 1929, exceeded those for any previous year in the company's history, including, 1928, which also was a record year.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

ELECTION of William Hastings Bassett, technical superintendent and metallurgist of the American Brass Co., Waterbury, Conn., as president of the American Institute of Mining and Metallurgical Engineers, was consummated at the recent meeting of the organization. Since his graduation from the Massachusetts Institute of Technology in 1891, Mr. Bassett has been active in metallurgical work. His first position after completing his schooling was that of chemist for the Pope Island Mfg. Co., where he remained until 1895 when he accepted a position as teacher of chemistry in Swain Free school. He continued in that capacity for several years after which he became connected with New Jersey Zinc Co., New York, for two years and for the next nine was chief chemist and metallurgist, Coe Brass Co., Farmington, Conn. He was appointed to his present position in 1912.

FOR distinguished service in engineering and science William LeRoy Emmet, consulting engineer with the General Electric Co., Schenectady, N. Y., has been awarded the American Society of Mechanical Engineers medal. It was presented to him at the fiftieth anniversary celebration of the organization at Washington, April 8. Mr. Emmet's most notable work has been in steam turbine design, and developments and inventions of the mercury vapor power process. Two years after his graduation from the United States naval academy, at Annapolis, in 1881, he resigned from the navy to take up electrical engineering. He received a D.Sc. degree from Union college. Since 1892 he has been associated with the General Electric company, except for the period of the Spanish-American war when he re-entered the navy. Mr. Emmet has been a member of the American Society of Mechanical Engineers since 1902 and is past president of the American Institute of Electrical Engineers.

SHARING the honor of the George Montefiore prize award is C. F. Wagner, prominent Westinghouse engineer. The award was presented in recognition of his contributions to scientific advancement in the technical applications of electricity. This triennial prize presented by the Foundation George Montefiore of Liege, Belgium, for the best original work on technical applications of electricity, was presented to Messrs. Wagner and Evans for their papers mentioned in the sketch of the latter, starting at the end of this page. After graduating from Carnegie Institute of Technology in 1917, Mr. Wagner studied for a year at the University of Chicago. Joining the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., he occupied a position in the research engineering department, later transferring to transmission engineering in which division he now holds an important position.

THE recipient of the Melville medal, Joseph W. Roe, is professor of industrial engineering at New York university and was presented with the token during the anniversary celebration of the American Society of Mechanical Engineers for his paper on "Principles of Jig and Fixture Practice." Prof. Roe received his Ph. B. degree from Yale university in 1895 and his degree in mechanical engineering in 1907. He is author of "English and American Tool Builders," which he wrote in 1916 while assistant professor of machine design, Sheffield Scientific school, Yale university. A member of the American Society of Mechanical Engineers since 1903, he also holds memberships in a number of other organizations.

AS DESIGNER of the Packard diesel aircraft engine which is described on page 38 of this issue, Capt. L. W. Woolson comes to the front with a singular engineering attainment. His engineering record began with his graduation from the University of London. Born in Los Angeles, Calif., in 1888, Capt. Woolson is a native of this country. His early automotive experience was obtained with the Mercedes Automobile Co. Later he was with the Western Electric Co., Bijur Motor Appliance Co., and served in the U. S. army. Since 1919 he has been with the Packard Motor Car Co. as aircraft and research engineer.

IN RECOGNITION of his contributions to scientific advancement in the technical applications of electricity, R. D. Evans, Westinghouse engineer, was named to share the award of the

Leaders in Design, Engineering and Research

WILLIAM H. BASSETT

WILLIAM L. EMMET

C. F. WAGNER

JOSEPH W. ROE

CAPT. L. M. WOOLSON

R. D. EVANS

George Montefiore prize for 1929. He received it in conjunction with C. F. Wagner, also a Westinghouse engineer, Algeri Marine, of Rome, H. Parodi and Pestarine, of Paris. The prize was given to Messrs. Evans and Wagner for their papers on "Studies on Transmission Stability" and "Static Stability Limits and Intermediate Condenser Station." The amount awarded them was 3000 Belgian francs. Mr. Evans is a prominent transmission engineer of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A graduate of the University of Oklahoma in electrical engineering in 1914, he has been connected with the Westinghouse general engineering department since that date.

* * *

Henry W. Sweet has been appointed chief engineer of the Krohn Differential Corp., Buchanan, Mich. Mr. Sweet is well known as a transmission engineer in the automotive industry and was chief engineer of the Brown-Lipe Gear Co., Syracuse, N. Y., for 16 years, after which he joined the engineering staff of Fuller & Sons Mfg. Co., Kalamazoo, Mich. He left this connection after the company was taken over by the Unit Corp. of America to become special designing engineer of the Chrysler Motor Corp., Detroit.

* * *

A. T. Colwell has been appointed chief engineer of Thompson Products Inc., Cleveland. He formerly was Michigan representative of the company. After having been graduated from West Point as a distinguished cadet in academic work in 1918, Mr. Colwell served as an instructor in the engineering corps of the army until 1922, when he joined the Thompson organization.

* * *

Schuyler Kleinhaas has been assigned to the design division of engineering department of Sikrosky Mfg. Co., Bridgeport, Conn. He formerly was with Keystone Aircraft Corp., a division of the Curtiss-Wright Corp., New York.

* * *

C. G. Williams, formerly with the Cincinnati Grinders Inc., Cincinnati, has been appointed chief engineer with the Green Bay-Barker Machine & Tool Works, Green Bay, Wis.

* * *

R. S. Begg, until recently chief engineer of the Stutz Motor Car Co., Indianapolis, has been appointed chief engineer for the Midland Steel Products Co., Cleveland, in full charge of its engineering activities including direction of the work of its new experimental laboratories. He was one of the organizers of the Jordan Motor Car Co., Cleveland, and was its chief engineer from 1916 to 1928.

* * *

Otto A. Banner has joined Busch-Sulzer Brothers Diesel Engine Co., St. Louis, as a consultant in matters relating to diesel engines and diesel gear drives. He formerly was chief engineer of the Falk Corp., Milwaukee.

* * *

Commander E. E. Wilson has been made president of the Hamilton Standard Propeller Corp., Pittsburgh. Election to this new office follows closely upon his appointment as vice president and general manager, which was noted in a recent issue of MACHINE DESIGN.

* * *

R. E. W. Harrison, chief engineer, Cincinnati Grinders Inc., Cincinnati, recently was nominated chairman of the committee appointed by the National Machine Tool Builders' association to study and submit proposals for the standardization of machine tool tapers.

* * *

Frank W. Curtis, until recently identified with P. R. Mallory & Co. Inc., Indianapolis, as chief engineer in charge of carboloy manufacture and developments, has become affiliated as research engineer with the Kearney & Trecker Corp., Milwaukee, manufacturer of milling machines.

* * *

Re-election of H. Hobart Porter as chairman of the Engineering Foundation has been announced. Otis E. Hovey and G. N. Clevenger were elected vice chairmen and Gano Dunn and George L. Knight were named additional members of the executive committee. Alfred D. Flinn was re-elected director and secretary.

* * *

Walter C. Robbins, formerly chief engineer and factory manager, has been elected vice president in charge of engineering and manufacturing for the Gabriel Snubber Mfg. Co., Cleveland.

* * *

Donald J. Bullock has accepted a position with Gazley & Lasha, consulting engineers, Washing-

(*Concluded on Page* 72)

MASTER OF THE AIR

AIR . . . . . last of the elements to be conquered by man has been subjugated by Steel. Once a scientific and hazardous experiment only, the Airplane has become an every day useful-servant . . . . . through Steel. Steel has made the airplane a sturdy, practical reliable tool of commerce . . . . . transporting passengers, carrying mail, hauling merchandise.

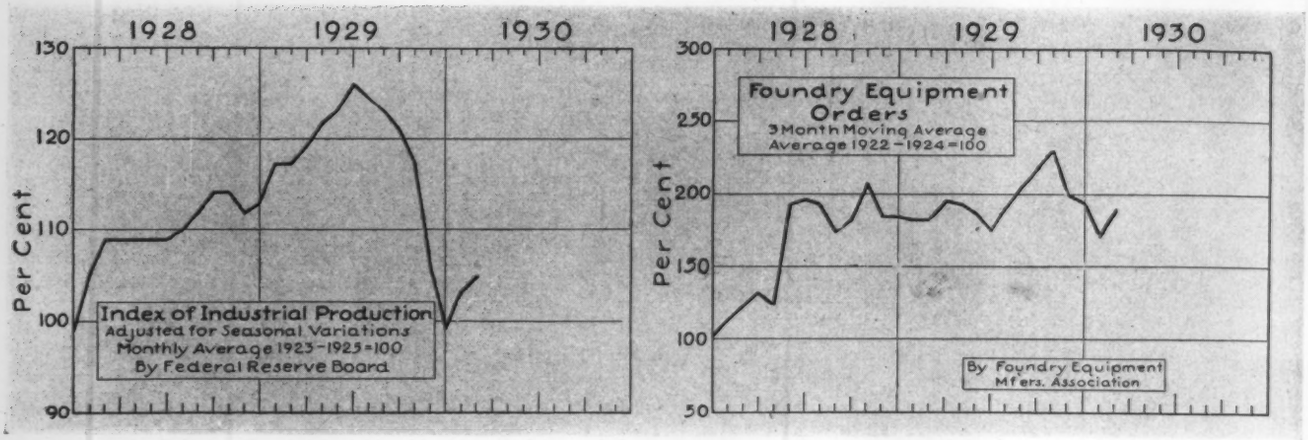
Distances have shrunk . . . . . wastes of water and desert now are swiftly and safely traversed . . . . . far and strange countries now are knit into close communities . . . . . alien peoples are made understanding neighbors . . . . . a giant new industry has been developed . . . . . all because Steel has overcome the limitations imposed upon the flimsy airship of the early days.

And Steel in the form of Cold Finished Bars is tremendously important in present day aircraft construction. Here, as in hundreds of other places where reliability is paramount to all other qualities—*no other material takes the place of Columbia cold finished Steel Products.*

Columbia Steel and Shafting Company Pittsburgh, Pa.

COLUMBIA

COLD FINISHED BARS AND SHAFTING

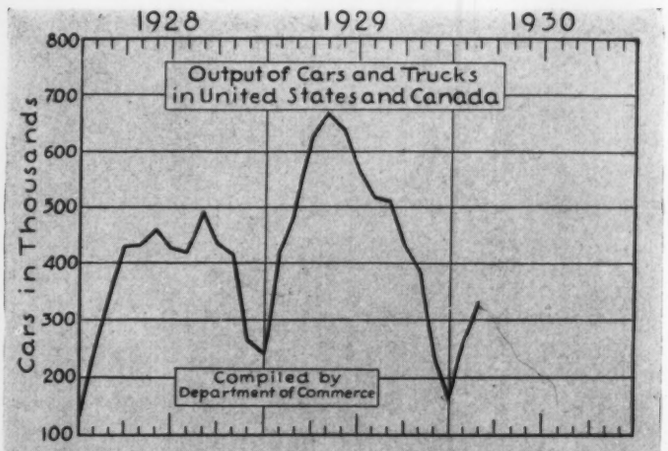


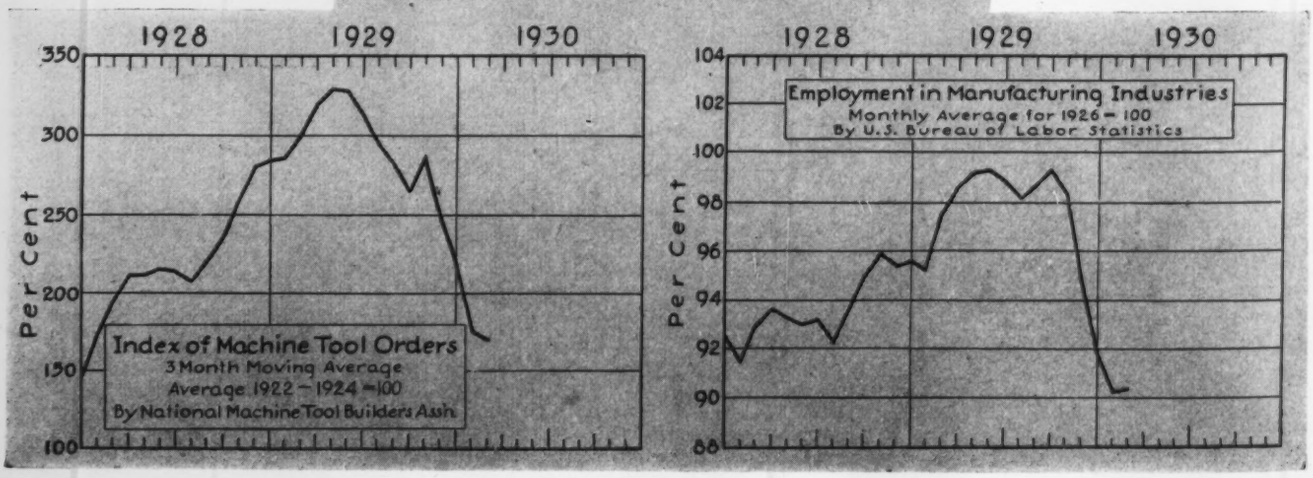
How Is Business?

WITH the advent of spring comes a gradual improvement in business conditions. Caution is being practiced in buying but the tendency is upward. Money rates have declined to the lowest levels since 1924 and employment conditions in general are better than a month ago. The trend is reflected in the accompanying charts. Machinery export trade is brisk.

Foundry equipment orders gained 30 points during February while the machinery and machine tool market shows a slight improvement over the past few months. Manufacturers are hopeful in their outlook on future business. The three months moving index for machine tools now stands at 172.6. A fair year for the automotive industry is predicted. February business of manufacturers in the automotive parts industry ran ahead of January. March showed further improvement and a seasonal increase is anticipated during the next few months. A pickup in the steelmaking industry is in prospect. Railroad equipment orders have been in good volume.

Prices on materials and parts used in the design and construction of machinery are reasonably stable. *Iron Trade Review's* indices of iron and steel prices continue to decline, although plates and shapes are selling at 1.80c, base Pittsburgh, and cold drawn bars and shafting (turned, polished), 2.10c. The price of copper is unchanged at 18.00c and 21.25c is asked for yellow brass. S. A. E. 6100 spring steel is quoted at 3.60c, net per 100 pounds; spring wire, 3.40c.





THE FINEST STEELS OBTAINABLE ARE USED IN FEDERAL BEARINGS.

THAT IS ONE REASON FOR THEIR OUTSTANDING LEADERSHIP.....

FEDERAL Radial Ball Bearings are made of the finest high carbon chrome steels. This is one of the outstanding reasons for "FEDERAL" superiority. The "FEDERAL" reputation for quality means long and economical service under all service conditions.

FEDERAL Radial Ball Bearings are built with the most exacting care. Continual checking of every operation. Each bearing part and every step in processing is individually tested, inspected and calibrated. "FEDERALS" are as near perfection as human skill can make them.

"FEDERALS" ARE PRECISION Bearings of the Highest Quality Backed by Years of Skill and Experience

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FEDERAL

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

PERVADED by an automotive atmosphere and suggesting much of interest to the design profession in general, the first regional meeting of the American Society for Testing Materials was held in Detroit, March 17-21. Over 500 engineers attended. Committee meetings were supplemented by a symposium covering automotive materials. Rapid progress was indicated in research work pertaining to the stainless steel and iron field under the guidance of Committee A-10 on the iron-chromium, iron-chromium nickel and related alloys.

Recommendation for a new definition for wrought iron was made by a subcommittee of Committee A-2 on wrought iron. The definition was unanimously approved and is as follows:

> Wrought iron is a ferrous material aggregated from a solidifying mass of particles of high refined metallic iron with which, without subsequent fusion, is incorporated a minutely and uniformly distributed quantity of slag.

Committee A-1 on steel reviewed developments of specifications for alloy steel castings for high-temperature service. Revision of present specifications for alloy steel bolting material is in prospect to meet requirements for considerably larger sizes. Committee B-2 on die cast metals and alloys concluded that its investigation has progressed far enough to merit immediate preparation of specifications.

* * *

Trial Run of Diesel Locomotive Successful

Success crowned the trial run of the 1200 horsepower pneumatic-drive diesel main line locomotive of the German National Railways late in 1929 and marked the culmination of the first stage development of this interesting unit begun in 1923. In an article describing the design and construction of the new unit in the February issue of *Diesel Power* it was stated that the locomotive negotiated the famous Geislinger grade of 2.3 per cent with a 257-ton train at a speed of 12½ miles per hour. The test train consisted of 10 cars. Basically, the idea behind the new design is the substitution of a diesel-driven single-stage air-compressing set with exhaust reheater to replace the steam boiler.

* * *

Campbell Memorial Lecturer Is Chosen

The Edward De Mille Campbell memorial lecture will be delivered by M. A. Grossmann, chief metallurgical engineer, Central Alloy Steel Corp., Canton, O., before the twelfth annual National Metal congress to be held in conjunction with the National Metal exhibition in Chicago, Sept. 22-26. The congress and exhibition are sponsored by the American Society for Steel Treating. Technical sessions will convene at the Stevens hotel. No choice has been made of Mr. Grossmann's subject.

* * *

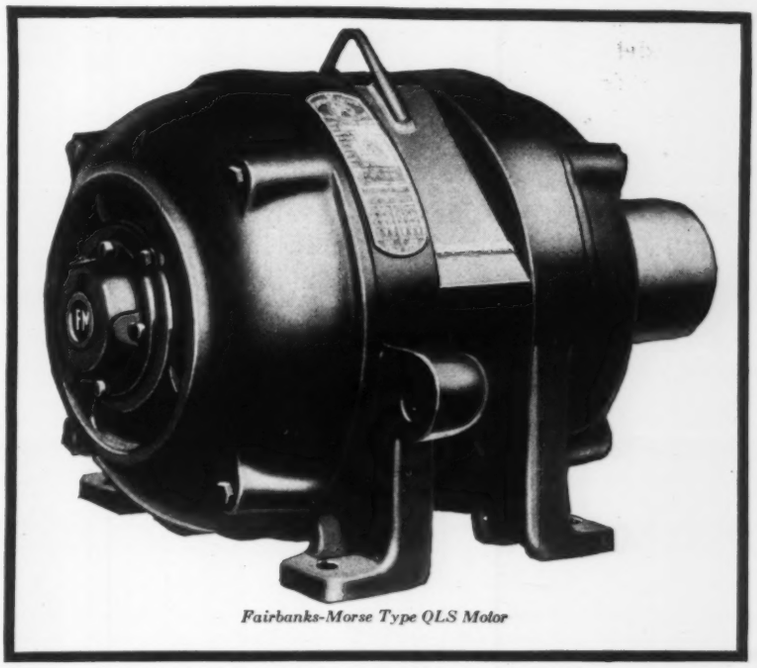
Instrument Detects Freezing Atmospheres

Atmospheric conditions conducive to the formation of ice are detected by a new instrument known as the "Hendrickson ice warner," developed by the bureau of standards for use on airplanes. The newly designed mechanism which consists of a thermal switch for installation on a strut or other part of the plane in the free air stream, is connected with an indicator in the cockpit. A red light in the indicator flashes on at temperatures between 26 and 32 degrees to warn the pilots. At these temperatures, according to experiments of the National Advisory Committee for Aeronautics, ice is formed in saturated atmospheres.

* * *

Design Improvements Feature Tractor Show

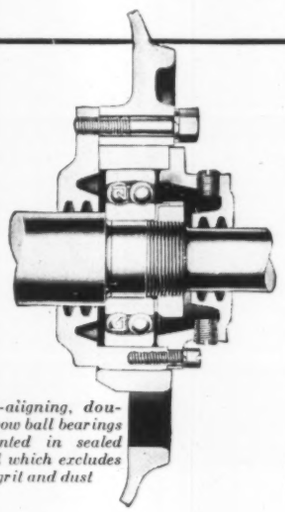
A tendency toward simplicity in design was indicated by the exhibits of $2,000,000 worth of agricultural machinery at the twenty-ninth annual Western Tractor and Power Farming show held recently at Wichita, Kans. One of the outstanding features was the small tractor designed



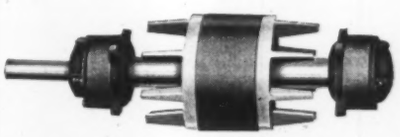
Fairbanks-Morse Type QLS Motor

See how

F-M Motors will help sell *your* machines



Self-aligning, double-row ball bearings mounted in sealed shell which excludes grit and dust



Complete rotor showing sturdy shaft and large, completely sealed ball bearings

IF you build motor driven machines—let the motor be a real selling factor. Fairbanks-Morse Type QLS (line start) Motors offer exclusive advantages that will attract buyers and make friends.

For instance, supposing you told a prospective buyer of your product that the motor (an F-M Type QLS) needed greasing *but once a year*. Would he be interested? He would. And you could tell him more—much more.

The bearings, for example—self-aligning, double-row ball bearings—are mounted in *sealed shells* which are absolutely dust tight. They stay clean *always* as the rotor may be removed without exposing them. Wear is practically eliminated. Mechanical losses are reduced. Electrical efficiency is high at full and partial loads. Motor life is greatly increased. Operating costs are reduced to a minimum.

There are other features—important features—about Fairbanks-Morse Type QLS Motors. These features will interest you because they can be made a selling factor for *your* machines. Complete details will be mailed promptly upon request.

FAIRBANKS-MORSE & CO.
900 S. Wabash Ave., Chicago
32 branches at your service throughout the United States

1930 begins the SECOND CENTURY of building FAIRBANKS SCALES

FAIRBANKS-MORSE MOTORS

EA40.32

for general purpose and row crop work. New 1930 model combines differed from their predecessors in refinements and size.

Users of farm machines are becoming more concerned with construction details and design of the units they operate. This was seen in the interest manifested by the 80,000 persons who attended. Machine parts employed in the construction of tractors, combines and other farming equipment comprised an interesting division of the exhibits. The tremendous popularity of power in farming was signified by the absence of horse-drawn equipment. Steam tractors also were missing.

* * *

DO-X to Attempt Flight Across Atlantic

A transoceanic air voyage across the Atlantic is being contemplated for the DO-X, the giant seaplane designed by Dr. Claude Dornier who now is visiting in this country. According to an announcement issued recently in New York, the flight will be made from Lake Constance late in June or July. Tentative plans include a crew of 12 besides probably 50 passengers. Twelve Curtiss Conquer aircraft engines will replace the present Siemens & Haskle Jupiter radial engines, increasing the horsepower of the craft from 6000 to 7200.

* * *

New Practices Prepared by Steel Treaters

Recommended practices recently prepared by the American Society for Steel Treating and published in the March issue of *Transactions* include two on bearing metals and one on nickel steel. These releases will be published in the new edition of the *Handbook* to appear about June 1. Titles of the releases are as follows: "Structure of Tin-Antimony-Copper Alloys Used as Bearing Metals," and "Constitution of Tin-Antimony-Copper Alloys Used as Bearing Metals," by O. W. Ellis, director of metallurgical research, Ontario Research Foundation, Toronto, Ont.; and "Nickel as Alloying Element in Steel," by Thomas H. Wickenden, International Nickel Co. Inc., New York.

* * *

British Automotive Engineer Designs Diesel

Louis Coatalen, noted British automotive engineer and designer of the "Silver Bullet," the racing car in which Kaye Don is attempting to beat the world's land speed record at Daytona Beach, Fla., has developed a high-speed injection diesel engine. He claims that the new unit will revolutionize automobile and aircraft design and make air, land and water transport absolutely free from fire hazards. Moreover, Mr. Coatalen believes he eventually can produce an engine weighing only 4 pounds per horsepower which will be more easily controlled than the gasoline engine.

* * *

National Western Metal Congress Date Set

Announcement that the second biennial National Western Metal congress and exposition will be held in the Civic auditorium, San Francisco, Feb. 16-20, 1931, has been made by W. H. Eisenman, secretary of the American Society for Steel Treating, principal sponsoring organization. Western sections of 12 national societies will cooperate with the American Society for Steel Treating in arranging the technical programs and organizing the exhibition. The first Western Metal congress and exposition was held at the Shrine auditorium, Los Angeles, in January, 1929. At that time a total of 176 firms exhibited. It is believed that the 1931 show will be larger.

* * *

Switzerland Is Holder of Patent Record

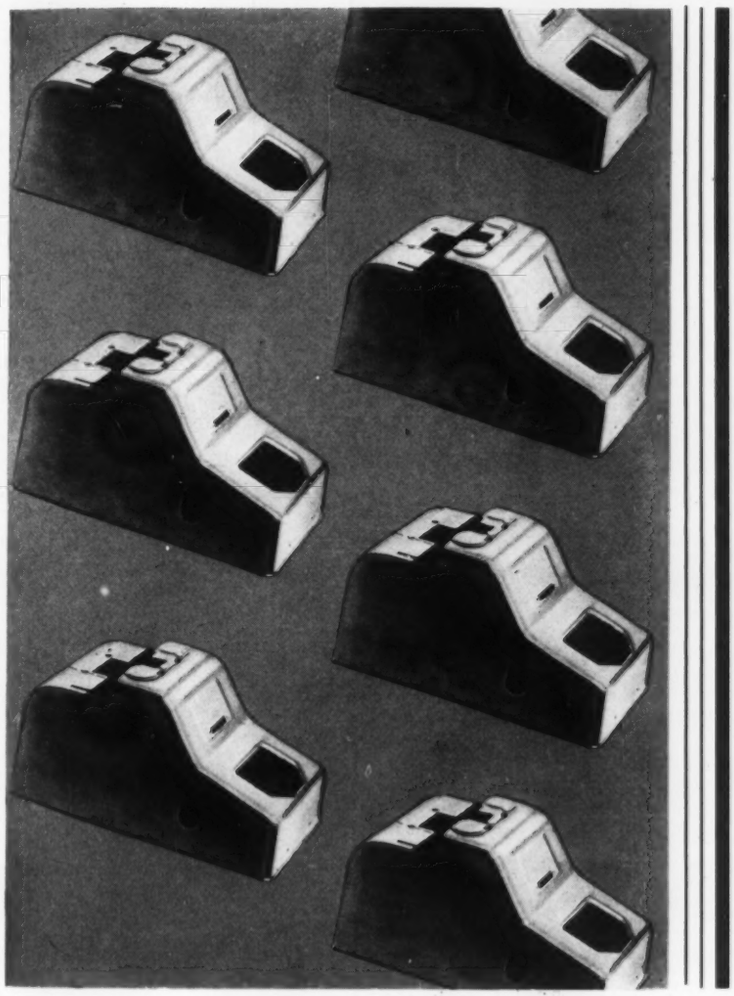
Comparative figures recently compiled show that Switzerland leads the world in the number of patents issued per million inhabitants. The United States took second place. According to the investigation covering a determined period, 382 patents were granted in this country while 542 Swiss patents were issued per million inhabitants. Other countries in rotation of their inventive record are: Sweden, third; Austria, fourth; Germany, fifth; Denmark, sixth; and Netherlands, Norway, France and Great Britain following in order.

* * *

Diesel-Driven Automobile Sets Fuel Record

A distance of 792 miles at an average speed of 31.7 miles per hour with a total consumption of 30 gallons of fuel oil was the record set by the first American diesel-driven passenger automobile as it arrived in New York recently from Indianapolis. C. L. Cummins, president of the Cummins Engine Co., is the builder of the engine. Comparatively, this record corresponds to a rate of approximately 26.4 miles per gallon with a 7-passenger car weighing 6000 pounds. Cost of fuel for the entire trip amounted to $1.38 the first full tank having been purchased at 4 cents per gallon and subsequent fillings to complete the trip at a somewhat higher rate.

Approaching Sales Problems from the Angle of Product Improvement



An 18 U.S. gauge seamless drawn steel cover, with reinforcing ledge around the bottom, designed by G. P. & F. to take the place of a casting formerly used on a business machine.

G.P.&F. Designing Engineers Can Assist You - - - -

IN this period of changing buying habits, many manufacturers are realizing the futility of simply urging the sales manager to get more business and let it go at that. They are analyzing the demand for more attractive, stronger and lighter products and are rendering practical assistance by approaching sales problems from the angle of product improvement.

But just what to do and how to do it successfully and economically is a problem requiring the attention of experienced designing engineers. G. P. & F. designing engineers can assist you. With a background of fifty years experience, they can give advice and suggestions, aid in speeding up the completion of new or improved models, and get them on the market. A few weeks or months saved means an earlier return of money spent . . . an earlier profit.

Let G. P. & F. engineers know your problems.

GEUDER, PAESCHKE & FREY CO.
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Please send your 1930 Booklet, "In Harmony with Modern Progress," to the address below. It is understood the writer is not obligated.

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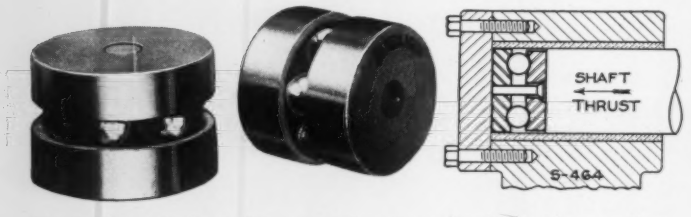
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged In the Design of Mechanisms or Machines

Develops New End-Thrust Bearing

MANUFACTURE of a new type of end-thrust bearing has been announced by Auburn Ball Bearing Co., Rochester, N. Y., after a number of years of experimentation. It is known as the Auburn T-114 RG thrust bearing and fits in the bore of the bushing at the end of



End-thrust bearing ready for installation. Sectional view at right shows its position at end of shaft

the shaft. This arrangement of installation of the bearing necessitates a minimum of machine work and represents a simple installation as shown in the accompanying drawing above at the right.

Because of the small pitch diameter of the ball groove for a given shaft diameter, and due to the large size balls used, the peripheral speed of the balls is relatively low, which adds to the capacity and life of the bearing. The two races and balls are held together as a unit by a rod in the center, which is flanged on the ends, permitting free rotation of the races, yet holding them together. Races are heavy in section and the grooves deep for severe service. Bearings are available in sizes from 1-3/16-inch to 3-15/16-inch diameters.

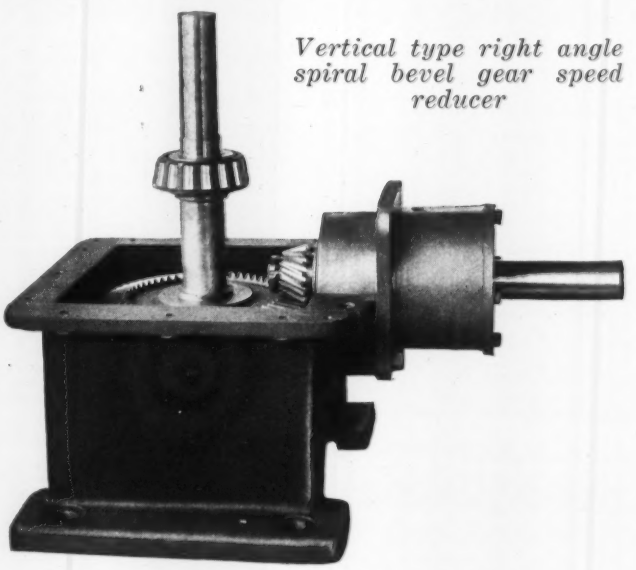
New Paint Resists Extreme Heat

EXTREME heat resisting aluminum paint known as "Ultra Fuzon" and claimed to have unusual properties when applied to steel parts recently has been announced by the Ultra Fuzon Distributing Co., 151 Fifth avenue, New York. This new material if applied to machine parts and subjected to a temperature of 500 to 700 degrees Fahr. until the liquid of the paint has evaporated, will fuse into the surface of the metal and will result in what might be called aluminum plating, giving the treated parts an attractive and glossy finish of lasting protective qualities.

After extensive research the company states that it finally succeeded in developing a chemically treated aluminum powder as the basis of this heat-resisting aluminum paint, which will withstand sustained temperature up to 2000 degrees Fahr. The paint is said to retain its silver color up to 1200 degrees, beyond which it becomes a dark gray. In applying the new product a brush, spraying or dipping may be used.

Speed Reducer Is Right-Angle Type

DESIGN of a new type of right-angle speed reducer consisting of spiral bevel gears mounted on tapered roller bearings recently was



Vertical type right angle spiral bevel gear speed reducer

announced by D. O. James Mfg. Co., Chicago. This new design includes both horizontal and vertical types with slow speed shaft extended either upward or downward so that the action may be

Tie *Speed and Quality* Together

In Machine Tools

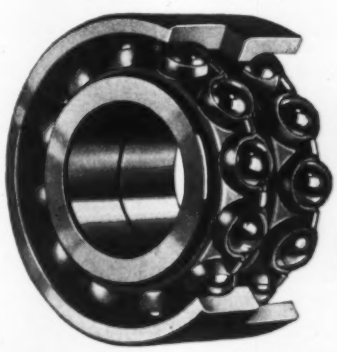
THE faster your spindles revolve — the greater the tendency toward chatter. Advances in cutting speeds have brought this new problem to the machine tool builder.

Extreme shaft and spindle rigidity is the only solution. Secure it with Gurney Duplex Ball Bearings — designed and manufactured for just such service.

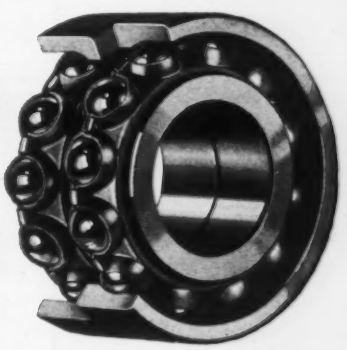
The Duplex provides the utmost in radial and thrust capacity . . . . carries extreme loads without friction or wear . . . . holds spindles in accurate alignment permanently.

Gurney Duplex Ball Bearings, promoters of economy, discourage machine tool troubles and definitely unite speed and quality.

Gurney Ball Bearing Division
Marlin-Rockwell Corp.
Jamestown, N. Y.



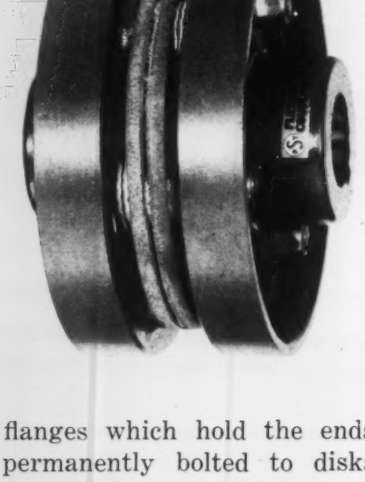
GURNEY
BALL BEARINGS



applied in the direction most convenient. Ratings range from ¼ horsepower to 100 horsepower with ratios 1:1 to 6:1. Larger reductions are obtained by the combination of the spiral bevel gear and planetary spur gears with ratios 8:1 to 1600:1. The gear teeth and bearings are lubricated by means of the splash system. The accompanying illustration shows one of the vertical-type reducers, with cover removed.

Coupling Employs Flexible Fabric

FLEXIBLE couplings of a new design have been announced by the Smith Power Transmission Co., 1213 West Third street, Cleveland. In this coupling the two close-grain gray iron



Flexible coupling showing flanges bolted to disks of flexible fabric. Elastic lock nuts are used

flanges which hold the ends of the shafts, are permanently bolted to disks of flexible fabric. Each flange is bolted alternately to the disks thereby eliminating metal-to-metal bearing surfaces, and insulating the two shafts. Friction thus also is eliminated and no lubrication is required. Corrugated washers prevent torque on the shafts from twisting the bolts out of the fabric. Special elastic stop lock nuts hold the bolts firmly and are not shaken loose by vibration. According to the manufacturer, FlexioD couplings act as a cushion, absorbing vibration, shocks and jolts, and can be used successfully on reversing drives because there is practically no lost motion.

New Copper Alloy Is Hardenable

WITH an approximate composition of 95 per cent copper, 4 per cent nickel and 1 per cent silicon, a new hardenable copper alloy known as "Tempaloy" has been developed by the American Brass Co., Waterbury, Conn. The nickel silicide goes into solid solution when heated to 750 to 800 degrees Cent., and if chilled from this temperature the alloy is ductile and soft. Heat treating at approximately 450 degrees Cent. for several hours precipitates the nickel silicide and the material becomes hard and strong, resembling mild steel in its physical properties.

Considerable strength is gained by the addition of aluminum to this alloy. The hardening properties also are accentuated. Tempaloy containing 5 per cent aluminum has a yield point of 25,000 pounds per square inch and a tensile strength of 65,000 pounds per square inch after quenching from 800 degrees Cent. Heat treating at 450 degrees Cent. raises the yield point to 100,000 pounds per square inch and the tensile strength to 130,000 pounds per square inch. When larger amounts of aluminum are added to this alloy the material has a tensile strength of 150,000 pounds per square inch.

Starter Embodies Arc Prevention

MANUAL operation is one of the features in the design of air motor starter known as type A-15, recently placed on the market by the Condit Electrical Mfg. Corp., Boston. The starter embodies the principle of arc prevention based on contacts of such shape, mass, relation and arrangement with respect to voltage and energy to be absorbed as to reduce the visual evidence of circuit interruption to a spark of negligible importance, even under heavy overloads.

Starter contacts are assembled in units on insulated carrier bases; one stationary and the other movable. The movable contact base can be withdrawn without the use of tools; permitting ready inspection of both movable and stationary

Interior view of motor starter showing stationary and movable contacts. Cover is drop type

ACCURACY demands ACCURACY!

THE accuracy of Diamond High Speed Roller Chain is such that the sprockets over which it operates should be equally accurate . . . if the roller-chain drive is to perform with the perfection of which it is capable. It *will* perform thus efficiently . . . if Diamond Sprockets are used.

Diamond-built sprockets are *accurate* . . . in tooth form and tooth dimensions . . . in diametrical dimensions . . . in concentricity . . . accurate in all the many details where sprocket-inaccuracies are commonly found. Diamond Sprockets are accurate because they are produced over modern precision-machinery by operators skilled in "close" work. They are *custom* sprockets, built in quantities large enough to maintain their prices at the level of the sprockets ordinarily offered you.

Using *Diamond* Sprockets with Diamond *High Speed* Roller Chain, you are certain of the utmost life from your drives. You are certain of the greatest period of trouble-free service. You are certain of economical and dependable power transmission. Diamond sprockets are durable, they generally outlast two or three replacement chains. Diamond sprocket-design automatically compensates chain-elongation . . . the chain rides higher on the tooth as the chain lengthens.

Various types of Diamond Sprockets for use with both single and multiple Roller chains are illustrated and described in the New Diamond Sprocket Catalog and Price List. It contains all information as to their application and selection . . . engineering data . . . tabulations . . . *prices.* A copy of this new booklet is yours for the asking; simply mail the convenient coupon.

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue Indianapolis, Ind.
Offices and Distributors in all Principal Cities

TRADE ◇ MARK

DIAMOND CHAIN
ROLLING ~ AT POINTS OF CONTACT

Accurately fabricated sprockets add to the life of a Roller Chain drive. Inaccurate sprockets detract not only from the life of the drive but from its effectiveness as well. Accurate sprockets are necessary with accurate roller chain and contribute to the recognized economy of the roller chain drive. Diamond Chain & Manufacturing Co.'s 40 years' experience in the production of quality roller chain and sprockets has enabled them to develop sprocket-fabrication to its maximum in accuracy.

◆ ◆ ◆

*The coupon is for your convenience in requesting a copy of this 44-page booklet—just off the press. You will find in it a detailed treatment of Diamond Sprockets, their application and selection. Full information is given for ordering, prices are shown. "Sprockets for Roller Chain" supplements *Catalog 57; you should have both. Mail the coupon for a copy.*

**If you do not have Catalog 57 write it in the margin of the coupon and we'll gladly send copies of both catalogs.*

Diamond Chain & Mfg. Co.
435 Kentucky Avenue
Indianapolis, Ind.

Please send me by return mail a copy of your new booklet on Sprockets for Roller Chain Drives—without obligation.

Name .....

Firm Name .....

Address .....

City ..... *State* .....

(A-880)

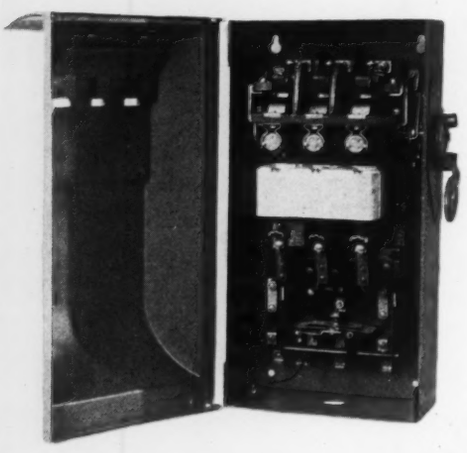
contacts. Stationary and movable contacts are identical and interchangeable.

The starter is unusually simple and compact, enclosed in a substantial steel case arranged with conduit knockouts. Thermal cutouts are provided for time-lag overload protection. Type A-15 is furnished for 7½ horsepower at 550 and 440 volts; 5 horsepower at 220 volts and 3 horsepower at 110 volts.

Linestarter Has Safety Features

A COMBINATION linestarter and safety switch, Class 11-200-HD, recently was developed by the Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa. This apparatus occupies a minimum amount of space, being more compact than a linestarter and a safety switch mounted in separate cabinets. A novel feature is the provision for inserting, while the motor is in operation and while the door of the cabinet is closed, a plug-type meter test jack to determine the load on the machine.

The equipment can be used with or without fuses; jumpers are supplied for use when fuses are not used. The safety switch has quick-break



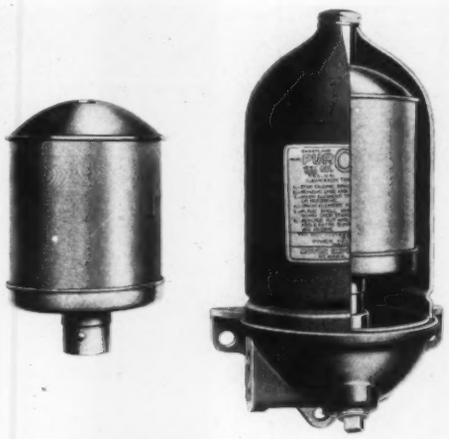
Details of interior of combined linestarter and safety switch

contacts; the handle is interlocked with the cover, preventing opening the door with contacts closed.

Oil Filter Has Variety of Uses

TO FILTER oil where it is used as a lubricant or in any class of service where a circulating flow is utilized, Motor Improvements Inc., Newark, N. J., has developed a unit known as the "PurOlator." Installations include machine tools, several types of diesel engines and other internal combustion engines. The various B-types, one of which is shown in the accompanying illustration, are of one general construction. They differ chiefly in the design of their bases to facilitate mounting upon different available surfaces.

The filtering element regularly supplied is of fabric and the dirty oil is introduced into the case



Oil filtering element shown at left occupies the inside of the unit at right

on the outside of this element. Under some conditions a metal filter is recommended. In developing this unit a large area was provided on an element occupying a space of small cubical measure. Because of the wedge shape of the metal ribbon from which the element is constructed, the filtering slots are wider behind the filtering edge than at the filtering edge. By this means an accurately determined degree of filtration is obtained.

Perfects New Aluminum Coating

FOR applying a new protective and decorative coating to aluminum and its alloys, an electrolytic method has been perfected by the Metals Protection Corp., 401 West Michigan street, Indianapolis. This coating, known as Alumilite, may be obtained in a silvery white or in a variety of colors including black, blue yellow, red, brown, green and purple. It becomes an integral part of the aluminum, according to claims, and will not crack, chip, or peel off. Treated sheets may be stamped and formed without marring the finish.

The new coating offers unusual resistance to atmospheric and salt water corrosion, will resist certain chemicals, but is not recommended for protecting aluminum from acids and alkalis. In almost any color it is not affected by hot water

An Aid To Fast Work

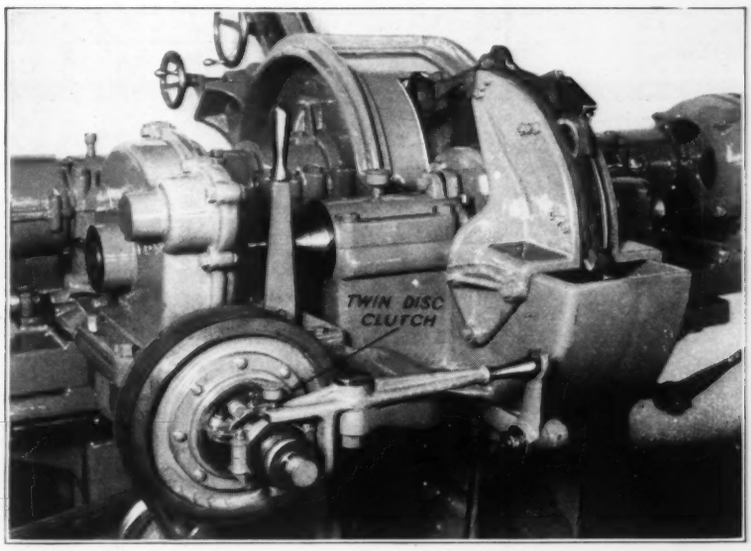


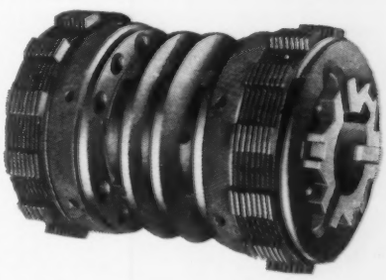
Photo by courtesy of Gardner Machine Co., Beloit, Wis.

IF MASS production means anything, it means continuous performance of automatics and special machine tools. No unnecessary delays can be tolerated.

Therefore, unfailing dependability is expected from every part and unit of machines built for modern production. The use of Twin Disc clutches in so many of the machines designed for this purpose, indicates the quality of Twin Disc performance.

We have specialized in clutches since 1917. Our line has been developed until it includes over 500 models, in oil sprayed and dry plate types, each designed to give some user better clutch service than he ever had before.

A request for information puts you under no obligation. Ask about the new C.C. type, specially designed for use in limited spaces.



Our new, compact Model C. C. clutch with operating mechanism in the hub. Available in single or duplex models, oil sprayed or dry plate. Write for sizes, dimensions and capacities.

TWIN DISC CLUTCH COMPANY

RACINE WISCONSIN

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TULSA, OKLA.
1645 East 16th St.
Mr. R. R. Sloan

TWIN DISC CLUTCHES

PARTS STATIONS

Boston, Mass.—Rapp-Huckins Co., Inc., 138 Beverly St.

Buffalo, N. Y.—Edward W. Rode, 45 A. St.

Cleveland—Industrial Engine Parts, Inc., 1053 E. 61st St.

Chicago—Motive Parts Co. of America, Inc., 2419 Indiana Ave.

Detroit—Whitney Brothers, 6464 Epworth Blvd.

Fort Worth, Tex.—Fort Worth Wheel & Rim Co., 312 Throckmorton St.

Houston, Tex.—Portable Rig Co., Inc.

Knoxville, Tenn.—Automotive Equipment & Supply Co.

Los Angeles—Coast Machinery Corporation, 464 E. Third St.

New York City—John Reiner & Company, Inc., 290 Hudson St.

Philadelphia, Pa.—Maerky Machine Works, 632 Race St.

Pittsburgh, Pa.—A. H. Krigger & Co. Smithfield & Carson Sts. Court 2496.

San Francisco—F. Somers Peterson Co., 57 California St.

Seattle, Wash.—Pacific Hoist & Derrick Company, 818 First Ave. South.

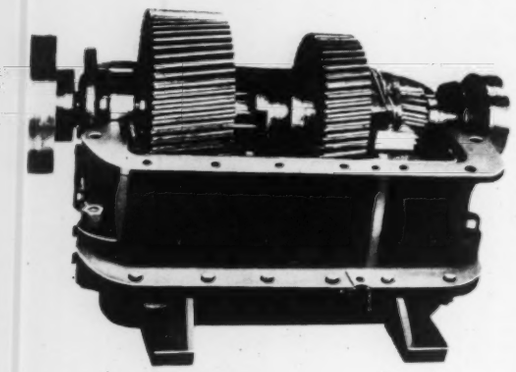
Tulsa, Okla.—Buda Engine Service Co. of Tulsa, Inc.

or steam. Other advantages include good wear resistance, unusual hardness, heat resistance to temperatures under 500 degrees Fahr., and can be lacquered or painted. The physical properties of aluminum are unaffected by application of the coating.

The Metal Protection Corp. is operating five job shops where work is processed for manufacturers having small production. Six more shops will be installed by May 1 and these with the present five, from Boston to Los Angeles, will constitute sales and service centers.

Gear Unit Provides Two Speeds

PROVISION for operation at two different speeds is a feature of the double-reduction gear unit for stoker drives, recently built by the



Inside of two-speed double-reduction gear unit for stoker drive

Nuttall works of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A high-speed pinion shaft and a splined shaft on which the change gear arrangement is assembled, are aligned directly above the shaft, with which are the intermediate gear and two slow-speed pinions. These pinions, each having a different number of teeth, are integral with the shaft of the unit.

A cross member inside the three-sectioned case carries one end of the high-speed shaft and one end of the low-speed splined shaft, the other ends of these shafts being supported by the end of the case. Two gears of different size on the low speed shaft are mounted on roller bearings so that they will turn freely on the shaft when not in use. Between these two gears a sliding clutch is manipulated by a lever from the outside of the case. Moving the sliding clutch toward one end or the other of the shaft engages either of the two gears, for high or low speed.

These units have a ratio of 5.88 to 1 in the high speed and 12 to 1 in the low speed, and are used with 12 horsepower motors operating at 600-900 revolutions per minute for slow speed service and 1200-1800 revolutions per minute in high speed service. One unit drives four stokers.

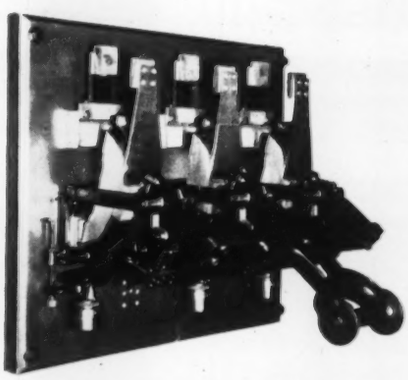
Lock Washers Are Stainless Steel

LOCK washers of stainless steel have been announced by the Reliance Mfg. Co., Massillon, O. The steel is drawn in the company's own mill and through a special rolling process is finished to a brinell of sufficient hardness to produce the stiffness and reactive pressure necessary in a spring lock washer.

Processing of this steel has been developed to make subsequent heat treating unnecessary and to develop a spring temper equal to the steel now generally used in the manufacture of lock washers. The company also markets stainless steel in coils or straightened and cut to length in rounds, flats, squares or hexagons from 0.022 up to 5/16-inch.

Air Circuit Breakers Are Trip Free

AIR circuit breakers, trip free from the handle on overcurrent, have been developed by General Electric Co., Schenectady, N. Y. Among the principal features of design is triple contact, easy replacement of the burning tips, and high pressure main contact formed of laminations



Air circuit breaker with three inverse time-limit overload tripping members

which make end-on contact with heavy and uniform pressure. The breakers are available for either instantaneous or time relay automatic operation in either single, double, or triple-pole combinations with necessary accessories.

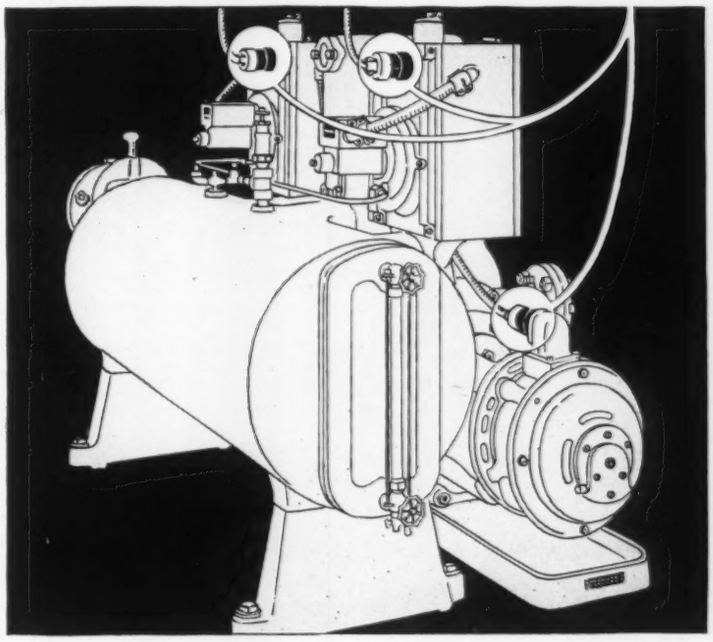
Three classifications of breakers for voltages

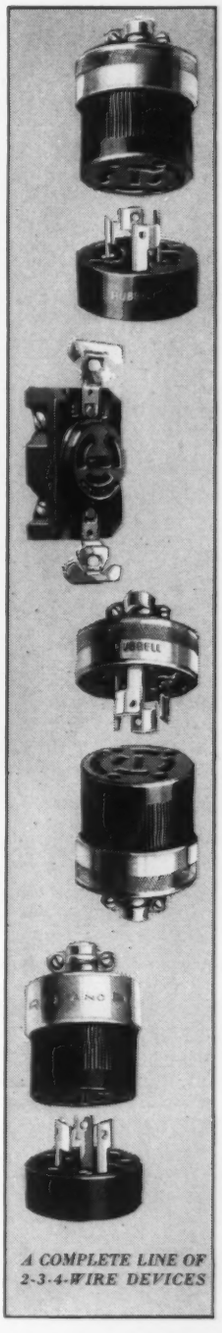
Easy Servicing

. . . of this heating pump provided by Twist-Locks

1. Plug in

2. Twist—it's locked!





A COMPLETE LINE OF 2-3-4-WIRE DEVICES

Twist-Lock Devices provide the Convenience of a separable connection with the Security of a direct connection

Every maker of a machine strives to build good equipment. Many go a step further. They provide for easier servicing of a machine by the buyer...a real sales advantage.

Disassembly convenience has been gained on all kinds of electrically operated and motor-driven machines through the use of Twist-Lock Devices in place of direct connections. No need to tear down these machines when a motor or part must be removed for repairs. The Twist-Lock Device can be easily separated when desired . . . yet it cannot part accidentally. The Security of Twist-Locks also recommends them for use in place of standard separable connections. They eliminate disconnection trouble. Since 3 and 4-wire Twist-Lock Devices provide for proper grounding, they protect the operator of a machine against electrical hazard.

You may be able to add worthwhile features to your equipment by simply incorporating these Safe and Sure devices. Find out—use the coupon.

HARVEY HUBBELL, INCORPORATED · BRIDGEPORT, CONNECTICUT

HUBBELL *Twist-Lock* Devices

Mail Coupon to our nearest office

Boston, Mass.
176 Federal St.

Atlanta, Georgia
138 Marietta St.
H. C. Biglin

New York City, N. Y.
122 East 42nd St.

Main Office:
Bridgeport, Conn

Chicago, Illinois
318 W. Washington St.

Denver, Colo.
1109 Broadway
T. H. Bodfish

Philadelphia, Pa.
Fifth St.
Philadelphia Bourse
(Exhibition Dept.)

San Francisco, Cal.
390 Fourth St.
Garnett Young & Co.

Please send information on Hubbell Twist-Lock Devices

Name_____

Address_____

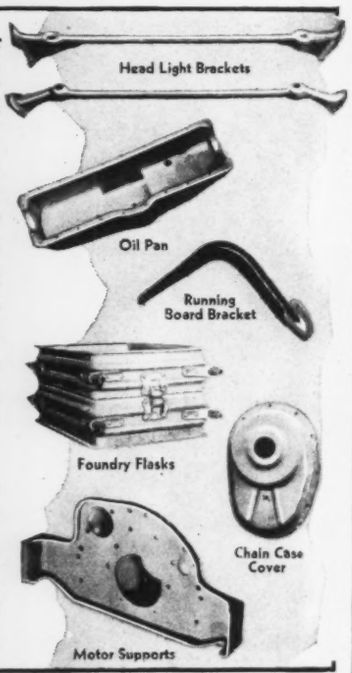
M.D. 4-30.

City and State_____

HEAVY PRESSED STEEL SECTIONS
in Large Quantities to the Most Exact Specifications

For the production of medium and heavy pressed steel sections, Truscon offers you an unusual service. All processes from initial design to complete assembly are under one supervision and responsibility, assuring prompt delivery. The greater accuracy and economy obtained through unit production result in better pressed steel products and lower costs.

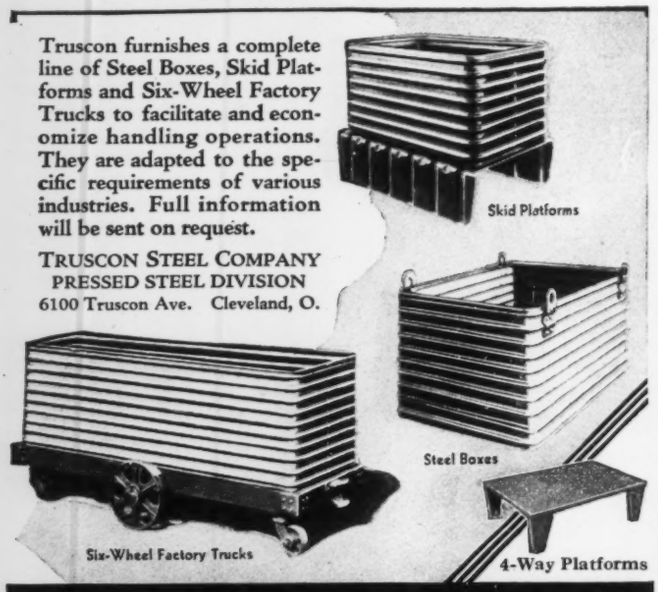
Manufacturers are urged to let Truscon Engineers cooperate with them in developing their products. Write for quotations on your pressed steel needs.



MATERIAL HANDLING EQUIPMENT
for Speed in Production

Truscon furnishes a complete line of Steel Boxes, Skid Platforms and Six-Wheel Factory Trucks to facilitate and economize handling operations. They are adapted to the specific requirements of various industries. Full information will be sent on request.

TRUSCON STEEL COMPANY
PRESSED STEEL DIVISION
6100 Truscon Ave. Cleveland, O.



SAVE WITH PRESSED STEEL

of 650 volts and below are announced as follows: Type CN-1 is a compact breaker applicable to industrial service and for circuits where the current is from 3 to 300 amperes; type CP-108 is a breaker for moderate duty service rated 1200 amperes and below; type CK-8 is a heavy-current breaker for moderate or heavy duty service ranging from 1600 amperes up.

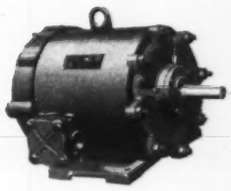
Design of Speed Reducer Improved

IMPROVEMENTS in the design of its speed reducer have been announced by the Cullman Wheel Co., 1346 Altgeld street, Chicago. The addition of roller bearings throughout, in place of the phosphor bronze bearings previously used, is a noteworthy change. In addition to this helical gears have supplanted plain gears. The oiling arrangement at the main gear bearing and at the point where the motor shaft enters the reducer, also has been changed.

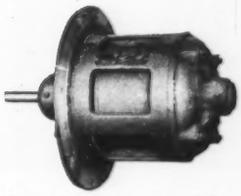
End view of speed reducer which is equipped with roller bearings and helical gears

The hub of the sprocket has been extended into the oil chamber, displacing the ring previously used, and a spray of oil is furnished to all points of the reducer by the sprocket chain. Complete drainage for the oil is provided by circular recesses. This insures a constant flow of oil about the bearing and also prevents it from passing beyond the recess. The new design has made practically no change in the limiting dimensions of the reducer. This unit also is referred to on page 20 of this issue.

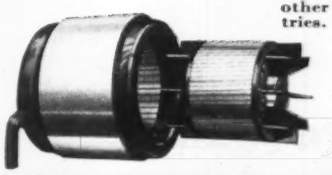
On the Cullman reducer, recently patented, the first reduction is obtained by a chain and sprocket drive, which reduces the first gear contact speed from two to six times the motor speed. This arrangement not only cuts down gear wear but also reduces noise.



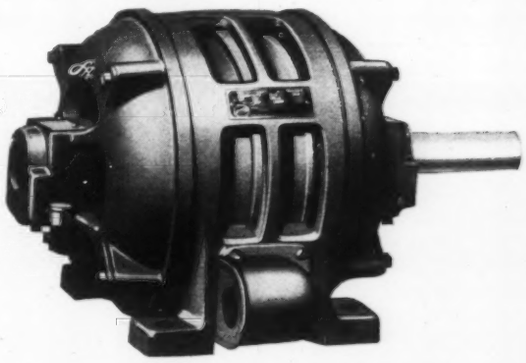
"Explosion-proof" self-ventilated motor specially constructed for use in dry cleaning rooms and other hazardous industries.



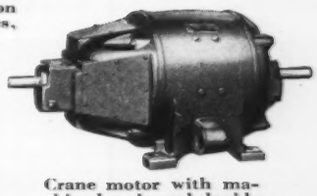
Flanged motor as used for direct mounting on drills, honing machines, etc.



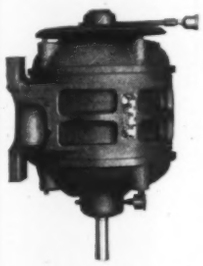
Shaftless rolled shell type motor for "built-in" construction. Used in machine tools, woodworking machinery, etc.



Multi-speed motor (simple squirrel cage type). Used wherever 2, 3, or 4 definite speeds, instantly available, are required. Typical applications include machine tools, woodworking machinery, bakery machinery, etc. Eliminates speed changing gears and clutches.



Crane motor with machined pads and double shaft for mounting brake, and with navy type front head.



Vertical motor with mushroom cover. Without base but with feet for mounting direct on side of open-top extractor.

Vertical motor with mushroom cover and ring base. For mounting direct on open-top extractor.

"CUSTOM-BUILT" *motors* .... make *GOOD* machines *BETTER!*

NO MATTER how *good* a machine may be, in itself—no matter how precise the design, nor how exact the performance of each part—its actual efficiency depends largely upon its motors. Machine excellence can be protected and enhanced by scientific motor application.

L.A. "Custom-built" motors are furnished with whatever unusual features are required—to produce the high efficiency and exact performance expected of a modern production machine. Sometimes this means a motor with special mounting features to eliminate unnecessary parts and to make the machine more simple and compact—or it may mean unusual construction of the entire motor to meet some peculiar operating condition—and sometimes the motor must be built with unusual torque characteristics to enable the machine to perform with an exactness that is impossible with an ordinary motor.

Such features of L.A. "custom-built" motors reflect utmost refinement in machine design. They make *good* machines *better*. That is why both users and manufacturers are realizing more and more—that machines do their work better—and are more saleable—when "L.A. equipped."

For Greater Machine Efficiency—Specify L.A. Motors

Prompt Deliveries — *Bulletins on L.A. "Custom-Built" motors will be sent you on request.* — Nationwide Service

LOUIS ALLIS

"CUSTOM-BUILT" *Electric* MOTORS

THE LOUIS ALLIS COMPANY
MILWAUKEE, WIS.

Motor Specialists for 28 Years ✓ *Offices in Principal Cities*

UNION

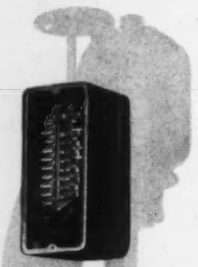
The Most Complete Line of Drum Controllers in the World

Skeleton Type Multi-Speed

Drum Controllers

This photo shows a Type Q-434-X non-reversing skeleton drum built into the frame of a sensitive drill press made by the Avey Drilling Machine Co., Inc., of Covington, Ky. The motor is a squirrel cage C.H.P. type.

The cover has been removed to show the drum in position and wired. The operating lever, which does not show in this picture, extends towards the front, within easy reach of the operator.



Application. Skeleton type drums are designed to obtain compactness and ruggedness within a limited mounting space. The practice of "building in" a motor is extending to control equipment. The controller is built into the machine casting, making a custom built design.

Mounting Methods. The machine manufacturer cores a hole in the machine base for mounting the controller within the cavity or builds a box designed to conform to the contour lines of the machine. The cavity can be designed to hold as many controllers as required. The motorized machine is completely wired, ready to operate, with only the connections of the power circuit to be made when installing.

Skeleton type drums furnished for 2, 3 and 4 speeds; constant torque, variable torque, and constant H. P.

UNION ELECTRIC MFG. CO.
942 Juneau Ave., Milwaukee, Wis.

Manufacturers of

Electric Motor Control Apparatus

Also Associated Manufacturer with, and Eastern Distributor for
DIAMOND ⟨E⟩ ELECTRICAL MFG. CO., *Los Angeles, Cal.*
Magnetic Motor Control Apparatus

MEN OF MACHINES

(*Concluded from Page* 54)

ton. He was formerly research engineer in the A-C Spark Plug Co., Flint, Mich.

* * *

Charles M. Otis has appointed development engineer of the Cincinnati factory of the American Laundry Machinery Co., Rochester, N. Y. He formerly was chief tool engineer.

* * *

Bennett Hill has been appointed chief engineer of the Dee Wite Boat Co., River Rouge, Mich. He formerly was engineer in charge of aviation engine design with the Horace E. Dodge Boat Works, Detroit.

* * *

Amos E. Northup has been appointed chief designer of the Murray Corp. of America, Detroit. Prior to his appointment he was chief designer with the Willys-Overland Co., Toledo, O.

* * *

W. A. Marschke, designer of the grinder named for him, has been appointed Indiana representative of Porter-Cable Machine Co., Syracuse, N. Y., in the sale of its sanders, grinders and saws.

* * *

Ford T. Nebel recently was elected president and treasurer of the Rahn-Larmon Co., Cincinnati, manufacturer of lathes. He has been connected with the machine tool industry for the past 30 years both as a designer and superintendent. Mr. Nebel has served as treasurer of the Rahn-Larmon company for the last nine years.

* * *

Prof. A. H. Blaïsdell, head of the mechanical and aeronautical engineering departments, Carnegie Institute of Technology, Pittsburgh, has been made chief technical advisor of Franklin Aircraft Corp., Franklin, Pa.

* * *

A. G. Geistert, assistant chief engineer, has been transferred from the Chevrolet Motor Co., Detroit, to the plant of Adem Opel, A. G., Russelheim-on-Mein, Germany.

Standardize on

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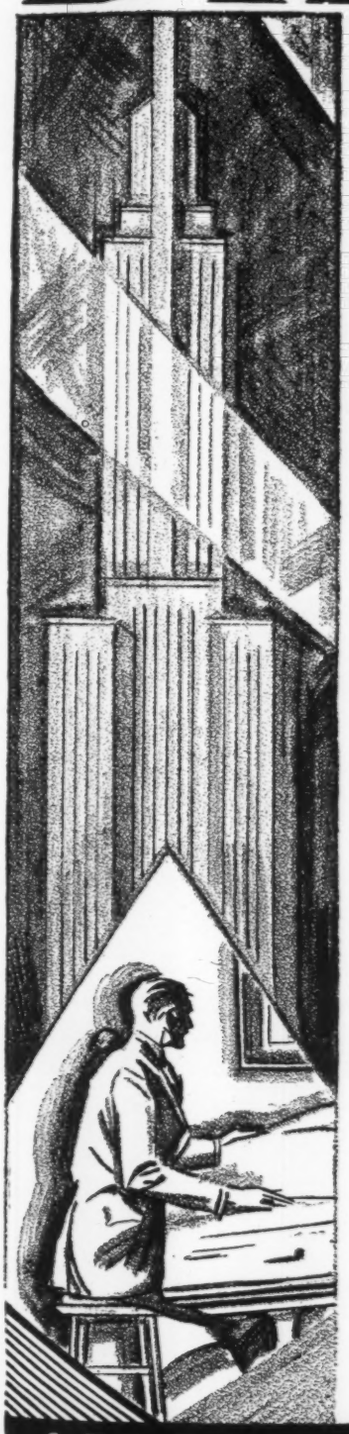
DRAFTING & SURVEYING SUPPLIES



DIETZGEN today has a most complete and standard line of drafting and surveying instruments, supplies and furniture—superlative quality blue print paper to meet every requirement of architectural, professional, industrial or school drafting. The name DIETZGEN is a reliable guarantee of quality and satisfaction.

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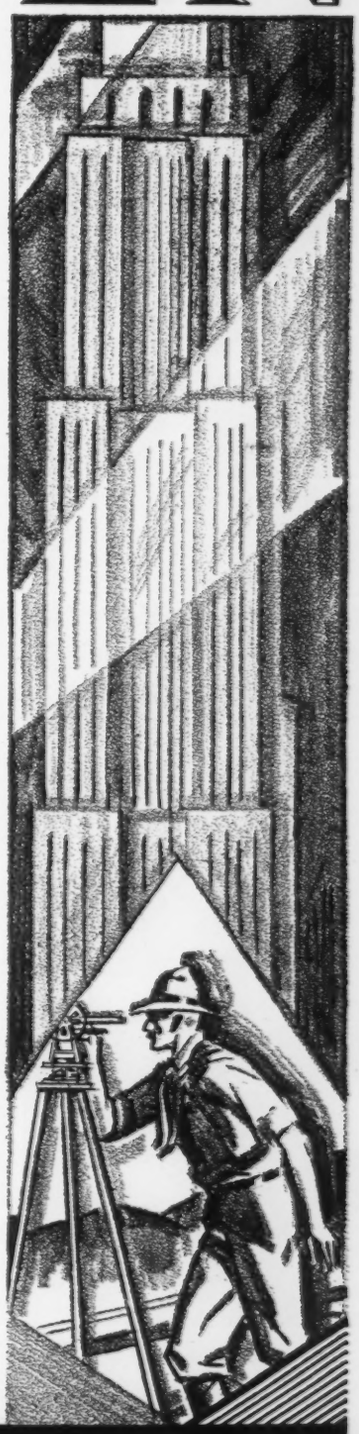
FARRAND RAPID RULE
HALDEN CALCULEX



EUGENE DIETZGEN CO.

Enduring worth at reasonable cost

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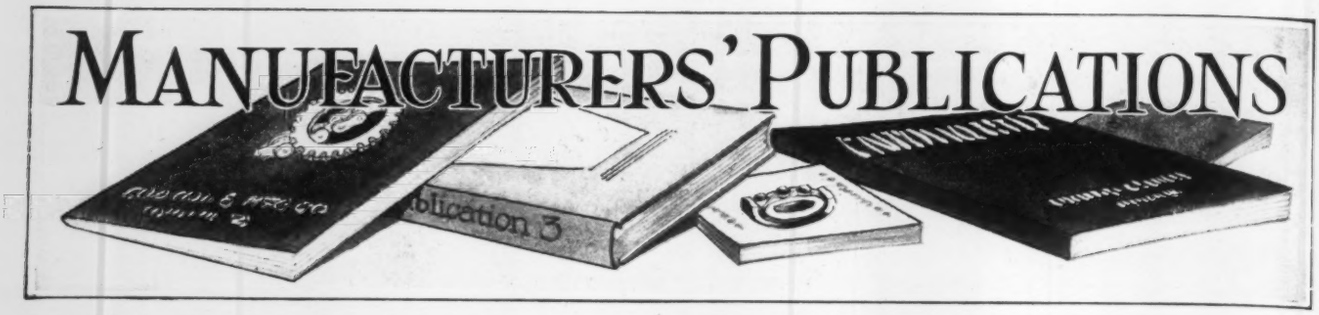
DIETZGEN ESTABLISHED 1885

Manufacturers of Drafting and Surveying Supplies

STANDARD FOR NEARLY FIFTY YEARS

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained without charge from the manufacturers of the products or through MACHINE DESIGN.

CHAIN DRIVES—A 44-page booklet on sprockets for roller chain drives is being published by the Diamond Chain & Mfg. Co., Indianapolis. Standard types of sprockets—plate, integral hub and detachable hub are illustrated and described. Complete mechanical specifications are shown for single and multiple-strand chains for drives rated up to 672 horsepower together with maximum horsepower and revolutions per minute limits. Other information includes recommended heat treatment for sprockets, instructions for ordering, specifications as to keyseats, a table of maximum hub diameters, etc.

SCREW THREADS—Use of its device to insure close fit of threads on bolts and nuts is emphasized in a leaflet by Jones & Lamson Machine Co., Springfield, Vt. Diagrams indicate the loose and close fit, which may be detected by the measuring device without sawing the nut.

GRAY IRON CASTINGS—North Wales Machine Co. Inc., North Wales, Pa., sets forth in a leaflet its philosophy of obtaining gray iron castings when and as wanted. The purpose is to call attention to the company's facilities for handling requirements of customers.

SPEED REDUCERS—A 60-page catalog describing its line of speed reducers has been issued by Palmer-Bee Co., Detroit. The text is supplemented by illustrations and data tables. Designers will find the departments on herringbone, mill-type, and worm gear speed reducers and on bases or bed plates for mounting reducers and motors particularly informative.

FLEXIBLE COUPLINGS—American Flexible Coupling Co., Erie, Pa., in a current bulletin describes its mechanical coupling which gives flexibility without flexible members. Illustrations show construction and method of operation and maintenance. A table of specifications is included.

DRAFT CONTROL—Shallcross Control Systems Co., Milwaukee, in a current bulletin describes its system of draft control for power plants. Illustrations cover the device and its application.

FOUNDRY PRACTICE—Whiting Corp., Harvey, Ill., is distributing a reprint of an address before the Chicago Foundrymen's club by R. S. MacPherran, chief chemist, Allis-Chalmers Mfg. Co., Milwaukee, on the trip he took in connection with the third international foundrymen's congress in London. It contains valuable data on foundry practice in Europe and data on perlite iron.

POWER FACTOR—Solution of power factor problems by scale is discussed in a bulletin by the General Electric Co., Schenectady, N. Y. The method by use of a triangle simplifies the calculation. The bulletin illustrates several problems to explain the method. Effects obtained from and probable costs of improving power factor by unity—power—fact synchronous motors, by capacitors or by synchronous condensers may be scanned and compared.

STEEL SHEETS—Authoritative information on exposure tests of steel sheets conducted by the American Society for Testing Materials is supplied in a booklet prepared by the American Sheet & Tin Plate Co. for general distribution.

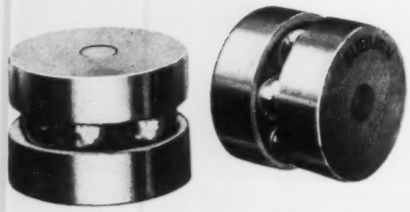
HEATING UNITS—A series of bulletins have been issued by Edwin L. Wiegand Co., Pittsburgh, describing its Chromalox heating units. The pages are replete with data tables and description supplemented by illustrations.

ELECTRIC STEEL—Latrobe Electric Steel Co., Latrobe, Pa., in a current catalog lists its various grades of elec-

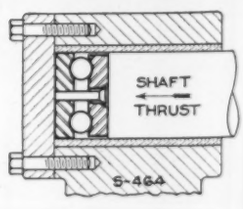
(Concluded on Page 76)

A NEW AUBURN THRUST

CHARACTERISTICS



High capacity long life
Simple low cost installation
Relatively low speed for given shaft diameter
Self contained unit construction
Heavy races, deep grooves, large balls



WRITE FOR DESCRIPTIVE DATA SHEET "THRUST 20-21"

AUBURN BALL BEARING CO., Trade Mark **59 Clarissa St., Rochester, N. Y.**

Established 1893

TRADITION

"Here, Lad—

We're getting awfully bothered with all these changes that are going on.

Every day I see changes in design.

We simply can't keep pace with them—we seem to be clay footed."

PROGRESS

"Yes, Pop—

with moulding clay.

My friend here, 'Arc Welding,' is an expert remover of this kind of clay.

If we're going to keep step we've got to be fleet-footed and the greatest help in this regard is that given by Lincoln Electric.

First they've developed the new *'Stable-Arc'* Welder to do the *right job* and then to do the *job right* they've just brought out a new series of Application Sheets.

Number One, entitled 'Fundamentals of Redesign,' is just off the press. It's the first step in the new pace.

I suggest that you write for a copy because the changes you speak of are coming so fast that about the only rest we can get is waiting for the traffic lights to turn."

The Lincoln Electric Co. Dep't. No. 37-4 Cleveland, O.

The Lincoln "Stable-Arc" Welder

— welds easier
— makes better welds
— permits greater output because of the steady uniform arc throughout entire welding range, which is the result of:

Variable voltage design
Laminated magnetic circuit
Separately-excited generator field
Double control of welding heat
All steel construction

No other welder has all these features.

"Stable Arc"

W-139

LINCOLN WELDER

(*Concluded from Page* 74)

tric steel for a wide variety of purposes. Much information as to special steels is included in the text.

BUS-BAR SUPPORTS—A circular on bus-bar supports has been issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. It describes the line of standard duty and heavy duty bus-bar supports, giving details of construction, distinctive features and fittings. Dimensioned drawings are included.

GENERATING SETS—Engberg division of the Troy Engine & Machine Co., St. Joseph, Mich., has issued a bulletin on its generator sets for stationary service. The engine and generator are shown in detail, with a drawing and table of dimensions.

CHAIN DRIVES—Morse Chain Co., Ithaca, N. Y., manufacturer of chain drives, has compiled a booklet of chain data. It gives information needed to design, install and maintain drives. It includes chain pitches, horsepower ratings and dimensions. Selection of sprockets and cutting of teeth are thoroughly described. The book also treats of speed reducers and flexible couplings, and shows their application.

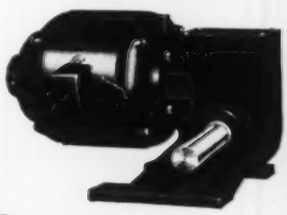
ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., in current bulletins, describing its hand-starting compensators and resistors. Illustrations and text cover these devices fully.

SPECIAL STEELS—Edgar Allen & Co. Ltd., Sheffield, Eng., has issued the tenth edition of its booklet on steels for motor cars and aircraft, bringing the subject to date. Graphs and data tables present much information relative to these special steels.

MAGNETIC CONTROLLER—Electric Controller & Mfg. Co., Cleveland, describes in a current bulletin its application of the Wright dynamic lowering circuit for faster crane operation. Charts show comparisons of speed obtained by this method and others.

SYNCHRONOUS MOTORS—General Electric Co., Schenectady, N. Y., continuing its campaign to further the interests of synchronous motors, has issued a booklet devoted to this type of power producer. The principle of this motor is explained, with the possibilities of its application to industrial power. Illustrations show details of construction and a large number of typical installations. The publication covers the field of this motor completely.

STEEL CASTINGS—Bulletin No. 125, Sivyer Reports, recently was issued to announce the merger of the Nugent Steel Castings Co., Chicago, with the Sivyer Steel Casting Co., Milwaukee. The new name of the company will be Sivyer Steel Casting Co., Milwaukee and Chicago. Illustrations show the facilities of the new organization for casting and heat treating small, variable sections, and wear-defying parts in steel.



A Complete Slow Speed Drive Assembly—

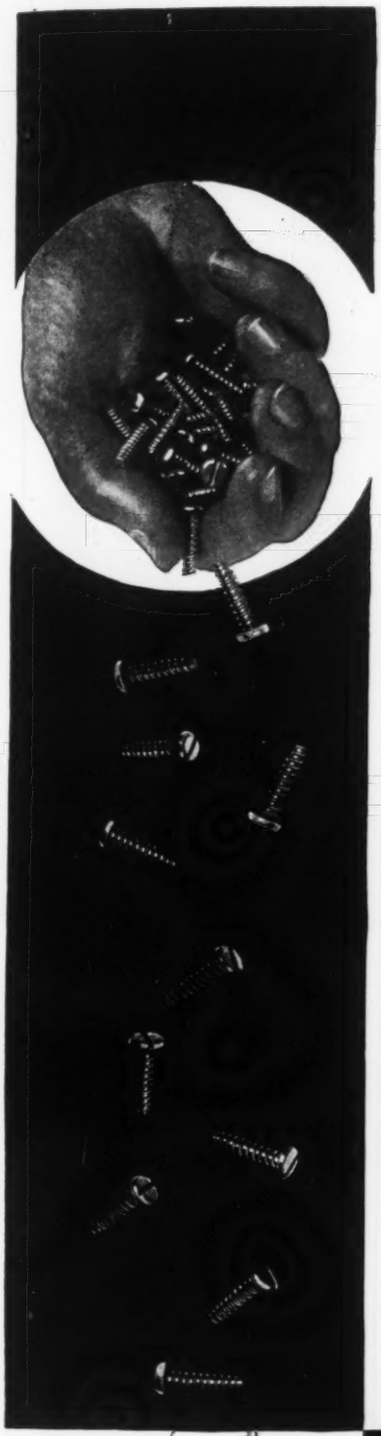
That's just what the Janette Motorized Speed Reducer has proved itself to be on many motor-driven appliances. This unit combines a motor, coupling and speed reducer in one compact machine. And because of its unique compactness it makes possible a neater and more machine-like design on equipment which it operates. Janette Motorized Speed Reducers are quiet, sturdy and inexpensive. 1/30 to 1/3 hp. Ratios: 20-to-1 to 70-to-1.

Write for bulletin SR-529

JANETTE MANUFACTURING COMPANY
558 West Monroe Street
CHICAGO

Singer Bldg.,
149 Broadway, New York

Real Estate Trust Bldg.,
Philadelphia



THIS HANDFUL of SCREWS

. . . eliminates 44 tapping operations on each PHILCO Radio

All along the assembly line at the plant of the Philadelphia Storage Battery Co., wise production heads have reduced cost and trouble to a minimum in the assembly of Philco Radio receivers and speakers. Tapping was one of the principal difficulties but it was quickly and effectively eliminated by Philco Engineers.

How?. . . Simply by replacing machine screws with Hardened Self-tapping Sheet Metal Screws. Forty-four of these unique Screws abolished 44 tapping operations on each Philco Radio. In addition they effected a saving in time and labor of over $16,000 in a year.

Used profitably on metal products of every description

The advantages gained by Philco are not unusual. Manufacturers of metal products of every description have obtained better fastenings, cut metal assembly costs and speeded-up production through the use of Self-tapping Screws.

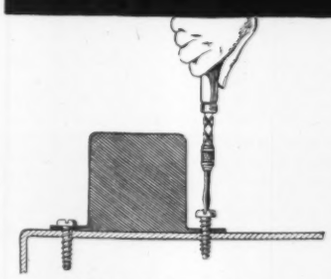
What will these Screws save on Your own product?

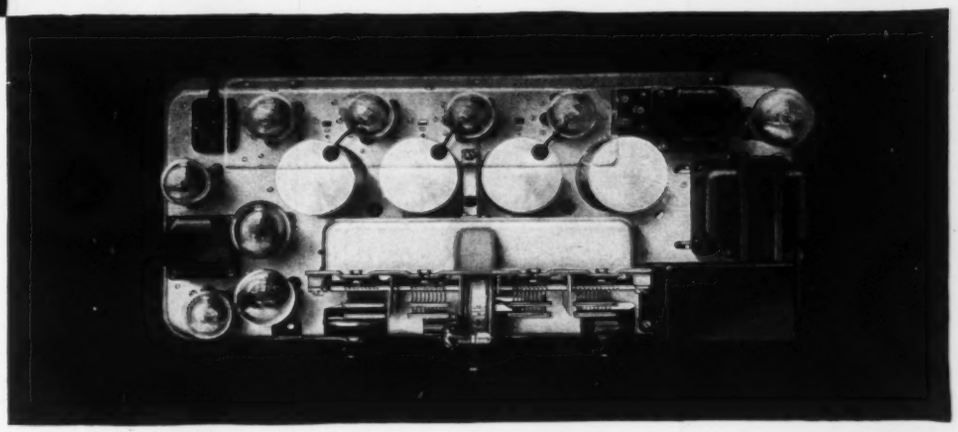
Find out! A test may show you how to make substantial savings on your own assemblies. We furnish proper samples for trial. . . just send a description of your assembly. Self-tapping Screws are made in two types:
Type "A"—for joining and making fastenings to sheet metal up to 14 gauge.
Type "Z"—for making fastenings to solid sections of aluminum and die castings, Bakelite, slate, etc. And to sheet metal up to 10 gauge.

PARKER-KALON CORPORATION
202 Varick St., New York, N. Y.

PARKER-KALON
HARDENED SELF-TAPPING
Sheet Metal Screws

PATENTED — APR. 1 1919 — No. 1299232 — MAR. 28 1922 — No. 1411184
AUG. 14, 1923 — No. 1465148 — FEB. 10 1925 — No. 1526182 — OTHERS PENDING



These Screws Tap their own Thread

Simply turn a Self-tapping Screw into a drilled or pierced hole. It taps its own thread in the metal or other material in which it can be used—holds better than a machine screw—even under vibration.